Surrogates for cryptogam conservation - associations between mosses, macrofungi, vascular plants and environmental variables.

Sapphire J.M. McMullan-Fisher B.Sc. (Honours – First class)

Submitted in fulfilment of the requirements for the
Degree of Doctor of Philosophy
at the School of Geography and Environmental Studies,
University of Tasmania - October 2008.

Supervisors:

Professor Jamie Kirkpatrick[1]
Doctor Tom May[2]
Doctor Emma Pharo[1]
Professor Richard Coleman[1]

[1] School of Geography and Environmental Studies, University of Tasmania
[2] National Herbarium of Victoria, Royal Botanic Gardens Melbourne

Declaration of originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed

Sapphire McMullan-Fisher
B.Sc. (Hons – First class) La Trobe University

Statement of authority of access

This thesis may be available for loan and limited copying in accordance with the *Copyright Act 1968*.

Abstract

Cryptogams are rarely included in conservation planning and management. This study aims to improve the data available for cryptogam conservation by focusing on two groups of cryptogams, mosses and macrofungi, to test the usefulness of vegetation type, vascular plants and environmental variables, including substrate, as surrogates for cryptogams in achieving satisfactory conservation outcomes.

Sites from four vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath) in the Hobart region of Tasmania were surveyed over a period of several years for vascular plants, mosses and epigeous macrofungi using permanent plots. Repeated sampling of the macrofungi ensured that a reasonable proportion of the taxa likely to be present were recorded. A total of 284 vascular plants, 71 mosses and 233 macrofungi were recorded.

Ordination and analysis of similarity both showed that the four vegetation types were significantly different from each other; this pattern occurred for vascular plants, mosses and macrofungi. Congruence between the three taxonomic groups was tested using Partial Mantel tests; all pair-wise associations were highly significant, showing highly predictive r-values. Significant and predictive associations occurred between environmental and substrate variables and biotic groups (vascular plants, mosses and macrofungi, and their various subsets). Canopy cover was the best single predictor of most biotic groups. Particular combinations of significant environmental variables had higher correlations with biotic groups than single variables, for example the combination of altitude, canopy cover and geology had higher r-values than any of these factors individually. Mosses and macrofungi exhibited high substrate fidelity across time and space. Substrate preferences of macrofungi did not vary among vegetation types, but mosses in wet forest occurred on a wider range of substrates than the same species in other vegetation types.

Iterative, optimisation, fully random and stratified random methods were compared for their effectiveness in the selection of sites for the conservation of vascular plants, mosses and macrofungi. When 10% of sites were selected for reservation there was little commonality in site selection between the three taxonomic groups. When 30% of sites were selected, at least 48% of all taxa were reserved by all approaches tested. The most useful data sets for selecting sites representative of the three taxonomic groups were vascular plants, named species from all three taxonomic groups and sites selected randomly with equal proportions of each vegetation type.

The results suggest that coarse scale conservation of vegetation types with reservation of at least 30% of their area should conserve common mosses and macrofungi. However, at the site scale, uncommon taxa (i.e. taxa only found on a single site) of mosses and macrofungi are not concordant with vascular plants. Associations of moss and macrofungal species with particular substrates and microhabitats may assist with site selections for reservation. For adequate management, further research is required on the occurrence and substrate and habitat specificity of rare taxa.

Statement of co-authorship

Two scientific papers have been previously published and are referred to in the thesis. Copies of these papers are included at the end of the thesis. In each case experimental design and research program, data analysis, interpretation of results and manuscript preparation were the primary responsibility of the candidate, but were carried out in consultation with supervisors. The contributions of co-authors are outlined below:

McMullan-Fisher, SJM, May, TW and Kirkpatrick, JB 2003. Some macrofungi from alpine Tasmania. *Australasian Mycologist* **22**, 44-52.

Supervisors TW May, and JB Kirkpatrick contributed to the development of ideas of this paper as well as providing advice on manuscript preparation.

McMullan-Fisher, SJM, May, TW and Keane, PJ 2002. The macrofungal community and fire in a mountain Ash forest in southern Australia. *Fungal Diversity* **10**, 57-76.

This was produced from the authors Honours degree at La Trobe University, Bundoora. Supervisor TW May contributed to the development of ideas and manuscript preparation. Supervisors JB Kirkpatrick and PJ Keane provided advice on manuscript preparation.

Acknowledgements

Firstly thanks must go to my supervisors for their ongoing support: Jamie for making it all possible, Tom for making positive critiques, Emma for balance and bryophytes, and Richard for asking good questions.

I owe much to the doctors and nurses who put me back together, and the therapists who keep my body working - so thank you for all your support.

Thanks to everyone in the School of Geography and Environmental studies for making it a great place to get things done, particularly, Kate for being unfailingly kind and helpful and Darren for making the computers play nice.

I couldn't have done fieldwork without the time, company and help of all the folk who braved the field – particularly Paul Smart, Brad Herd, Alex Hale and April Wakefield.

Thanks to my fellow students for the support, the empathy and laughter, particularly those who have helped when I needed it most. So thanks: Anglea for the fabulous map; Janet and David for some data entry; Pep for help with learning to identify bryophytes; Maj-Britt for help with the statistical mysteries of R and the final thesis haul.

Thanks to all the encouragement and inspiration I have had from the fabulous people of the 'cryptic' groups: Fungimap, Australian Bryological Association, Australasian Mycological Society, Bryophyte Interest Group, and Queensland Mycological Society. Also to David and Genevieve for sharing their mountain.

Love and thanks for all the support and fun from my many friends: Alison, Angela, Anita, Anthea, Anne, Anna, Amy, Alex, Bel, Bishi, Brian, Cath, Cathy-May, Col, Dom, Emma, Evan, Grant, Greg, Jane, Julie, Kevin (K2), Kevin (Smiley), Leigh, Maj-Britt, Mel, Phil, Rod, Sandy and Simon.

Love and thanks to my family who have supported me from the get go and through the woe! Last but not least love and thanks to Mark who has been my rock and my joy through it all.

Table of Contents

Chapter 1 – Introduction

Introduction

Cryptogams (a group of convenience that includes mosses and macrofungi) are important in ecosystem function (see the 'cryptogam ecology' section below), yet there has been comparatively little research on their ecology, especially in comparison to the large volume of literature on vascular plant ecology (van der Maarel 1988; Whittaker *et al.* 2001; Brooker *et al.* 2008). Reasons why cryptogams are rarely considered in mainstream vegetation conservation management include their relatively small size, poor understanding of their roles in ecosystems, difficulties in identification and paucity of cryptogam specialists, large numbers of species, inadequate distribution data and their perceived ephemeral nature (Scott *et al.* 1997; Eldridge *et al.* 2003; Entwistle 2003; Gibson 2006; Hylander 2007).

This thesis assesses the effectiveness in conservation planning of using easily collected data sets on vegetation and environmental variables, including cryptogam substrates, as surrogates for data on mosses and epigeous macrofungi. This introductory chapter considers the context of cryptogam conservation, particularly for Australia.

Cryptogam biology

The term 'cryptogam' was introduced to describe plants (in a broad sense) which do not have seeds, but produce minute reproductive propagules, that are usually spores. With modern biological understanding, it is clear that the cryptogams are a hyper-diverse polyphyletic group, only some of which are true plants, and which includes members from a number of kingdoms. The term cryptogam is still useful as it is a concise and widely understood term for plants and plant-like organisms which are not phanerogams (seed plants) or ferns and fern allies. The plants and plant-like organisms are commonly divided into the vascular plants (tracheophytes) and the so called non-vascular

plants, like mosses. The terms non-vascular plants and cryptogams are often used interchangeably.

The term cryptogam as applied in this thesis covers bryophytes, algae, fungi and lichens. Historically, the ferns (Pteridophytes) also were included as cryptogams because they reproduced via spores. The ferns are not considered cryptogams in the present thesis. The cryptogamic groups which are specifically considered in this study are the mosses (Musci or Bryophyta *stricto sensu* (Selosse 2005)) and the macrofungi.

The fungi are typically included in three Kingdoms the Protoctista, Chromista and Eumycota (Hawksworth *et al.* 1995; Walker 1996; Kendrick 2000). The macrofungi are an arbitrary grouping from these Kingdoms based on the readily visible fruiting bodies (larger than 1 mm), that may be seen with the unaided eye. This study focuses on the epigeous macrofungi and does not include sequestrate (hypogeous) macrofungi. Macrofungi covered by the present study are all within the phyla Ascomycota and Basiodiomycota of the Eumycota, and the phyla Myxomycota of the Amoebozoa. These macrofungi include agarics, boletes, coral fungi, polypores, corticoid fungi, cup- and disc-fungi, and slime molds. Lichens are not included, except for a few basidiolichens such as *Marasmiellus affixus* and *Omphalina* spp. Lichens, although they are cryptogams and included in the Eumycota, are obligate symbionts with photosynthetic algae or cyanobacteria and have been traditionally studied separately from the macrofungi due to their quite different physiology and ecology.

Mosses are small, photosynthetic plants which contain no lignin and have a haploid-dominated (gametophyte) life-cycle (Scholfield 1985; Gibson 2006). Although they are considered non-vascular plants, many mosses do have conducting tissue (Buck & Goffinet 2000), which, in the leaves, often responds to changes in moisture to reduce water loss (Scholfield 1985). Hence, mosses are able to survive periodic desiccation. These plants have rhizoids, usually arising from the stems, which attach them to their substrate. Mosses are found in most ecosystems as their

poikilohydric nature and small size allows them to successfully colonise xeric or ephemeral habitats.

Cryptogam diversity

Estimates of the global numbers of fungi range from 712000 as a lower estimate (Schmit & Mueller 2007) to 1.5 million (Hawksworth 1991). These estimates are based on ratios of fungi to vascular plants in the order of two to six, derived from studies of thoroughly known areas, coupled with the current estimate of approximately 275 000 for vascular plants globally (Schmit & Mueller 2007). For macrofungi (Mueller & Schmit 2007), lists have been compiled from various regions to arrive at a worldwide figure of around 56000 species, and plant/macrofungus ratios have been used to predict 53000 – 110000 species globally. There are an estimated 15000 moss species globally (Hallingback & Hodgetts 2000).

Estimates of 16000 - 20000 vascular plant species (Orchard 1999; Schmit & Mueller 2007), 1100 moss species (Buck *et al.* 2002) and 3880 - 10000 macrofungal species (May & Avram 1997; Mueller & Schmit 2007; Schmit & Mueller 2007) have been determined for Australia. In Tasmania, there are approximately 1627 vascular plants (Reid *et al.* 1999) and 361-450 mosses (Dalton *et al.* 1991; Moscal *et al.* 1997; Buck *et al.* 2002). The only estimate for Tasmanian macrofungi is several hundred species (Brown *et al.* 1994). This is likely to be an underestimate, as Ratkowsky and Gates (2005) include 360 named species from forests alone and suggest that there is an equivalent number of currently unnamed taxa (Ratkowsky & Gates 2002; Gates & Ratkowsky 2004; Gates & Ratkowsky 2005; Ratkowsky & Gates 2005). There are approximately 15300-17000 Australian endemic vascular plants (Ecologically Sustainable Development. Ecologically Sustainable Development Working Group on Biological Diversity 1991), 300 Australian endemic mosses (Hallingback & Hodgetts 2000) and an unknown number of endemic macrofungi. There are approximately 306 Tasmanian endemic vascular plants (Reid *et al.* 1999), 26 Tasmanian

endemic mosses (McCarthy 2006) and an unknown number of Tasmanian endemic macrofungi.

Cryptogam ecology

Mosses are able to indirectly absorb nutrients from a broad range of substrates, including rocks, tree buttresses, wood and soil (Bates 2000). Mosses may play a number of roles in ecosystems. As photosynthetic organisms they contribute to the absorption of carbon dioxide and the productivity of their ecosystems. *Sphagnum* communities are considered in mitigation strategies for global warming (Dorrepaal *et al.* 2004; Davis & Crosby 2007). Mosses are able to stabilise soils and, with other cryptogams, are components of soil crusts which are particularly important in semi-arid Australia (Eldridge 1994; Eldridge & Koen 1998; Eldridge 2003) and globally (Perez 1997; Belnap *et al.* 1999; Evans & Johansen 1999; Gaskin & Gardner 2001). Mosses are able to trap and retain moisture and so are important elements of localised water relations (Scholfield 1985; Bates 2000). Finally, mosses provide habitat for animals, invertebrates in particular.

Macrofungi are the visible reproductive structures (sporophores) of an individual fungus. Although rarely seen, the fungal mycelium makes up the 'body' of the fungus and it is this portion, growing in or on the substrate, that carries out most of the ecological functions. As heterotrophs, fungi have three main nutritional strategies: saprotrophism, parasitism and mutualism. These three strategies also relate to their functional roles in ecosystems (Dix & Webster 1995).

The saprotrophic fungi absorb nutrients from dead organic matter and, along with microbes, play an important part in nutrient cycles, particularly the decomposition of lignin. Saprotrophic macrofungi include both soil and wood inhabiting fungi. There are a number of mutualisms found between plants and fungi, including lichens, endophytes and mycorrhizae. Macrofungi are rarely endophytes or lichenised, but many form mycorrhizae. There are a number of types of mycorrhizae, all of

which are important for the development, growth and survival of the associated plants (Brundrett 1991; Colpaert & Van Tchelen 1996; van der Heijden & Sanders 2002). The mycorrhizae formed by macrofungi are almost all ectomycorrhizae, where a sheath is formed on the roots of host plants (van der Heijden & Sanders 2002). Mycorrhizae are thought to affect plant community composition (Amaranthus & Perry 1994).

There is an important connection between many Australian plants and mycorrhizal fungi, which is mediated by mycophagous vertebrates, particularly marsupials like the bandicoots (Peramelidae), potoroos (Potoroidae) and bettongs (Potoroinae) (Claridge 1992; Taylor 1992; Lamant 1995; Vernes & Haydon 2001). These studies focused on the sequestrate (hypogeous) mycorrhizae which are not studied in the present thesis.

There are a relatively small number of parasitic macrofungi compared to the large number of parasitic microfungi. These are often associated with trees, and include *Armillaria* and some of the polypores. Parasites are important in ecosystems, as in the short term they create gaps in ecosystems and in the long term they allow evolutionary development through the reduction of fitness of susceptible hosts. Many of the novel metabolites found in fungi are thought to have evolved as a response to co-evolution between parasites and their hosts. Another ecological role of the fungi is as a source of food. There are many invertebrates that are mycophagous (Lawrence & Milner 1996; Moore 1996; Wertheim *et al.* 2000). These invertebrates often feed on both the fungal mycelia and the sporophores and are not restricted to mycorrhizal fruit-bodies, as the mycophagous marsupials tend to be.

Current Australian cryptogam research

The research that has been carried out on Australian cryptogams is most often taxonomic in nature or involves inventories of biodiversity (Scott & Stone 1976; Grgurinovic 1997; Bougher & Syme 1998; Young 1999; Bougher & Lebel 2002; Grgurinovic 2003; Grgurinovic & Simpson 2003;

Morley & Gibson 2004; McCarthy 2006). Many of the inventories of cryptogams have been carried out in Tasmania (Ratkowsky 1982; Kantvilas & Jarman 1993; Jarman & Kantvilas 1994, 1995b; Jarman & Kantvilas 1995; Jarman & Kantvilas 1997; Moscal *et al.* 1997; Jarman & Kantvilas 2001; Ratkowsky & Gates 2002; Gates & Ratkowsky 2004; Kantvilas & Jarman 2004; Gates & Ratkowsky 2005).

Cryptogamic ecological studies are not common in Australia. Wet forest, heathy woodland, grassy woodland and alpine heath are the four vegetation types examined in the present study. Forests have the highest number of ecological studies for both bryophytes (e.g. Ashton 1986; Blanks 1996; Pharo & Beattie 1997; Pharo *et al.* 1999; Pharo *et al.* 2000; Pharo & Blanks 2000; Pharo & Beattie 2001; Pharo & Beattie 2002; Pharo *et al.* 2004; Pharo *et al.* 2005; Turner & Pharo 2005; Dell & Jenkin 2006; Floyed & Gibson 2006; Kellar *et al.* 2006; Turner *et al.* 2006) and macrofungi (e.g. McMullan-Fisher *et al.* 2002; Packham *et al.* 2002; Robinson & Bougher 2003; Gates *et al.* 2005; Ratkowsky & Gates 2005). Little work has been carried out in the other three vegetation types considered in the present study, i.e. heathy woodland (e.g. Syme 1992; Kirkpatrick 1999); grassy woodland (e.g. Eldridge *et al.* 2000; Pharo *et al.* 2005; Eldridge *et al.* 2006); and alpine heath (e.g. May & McMullan-Fisher 2003; McMullan-Fisher *et al.* 2003).

Planning for cryptogam conservation

Modern conservation planning is concerned with more than just protecting species. For long term conservation to be successful, ecosystem function must be maintained (Risser 1995; Poiani *et al.* 2000; Singh 2002). Unfortunately, the limits of functional redundancy or ecosystem resilience are not yet known for most ecosystems (Loreau *et al.* 2001; Loreau 2004), making it particularly important to consider ecosystem function when conservation planning (Chan *et al.* 2006; Faith 2006). Given the functionally important roles of the mosses and macrofungi, these groups warrant consideration as part of conservation plans. Compared to many of the vascular plants, mosses and macrofungi

have different functional roles. Thus, they may have different requirements in conservation planning and management.

The state of Australian terrestrial cryptogam conservation was reviewed ten years ago (Scott *et al.* 1997). Sadly, most of the recommendations from this review have not been taken up, although a number of field guides have been published and there has been some new taxonomic work on Australian cryptogams. Scientific understanding of cryptogams in Australia is still in its early stages. For example, basic taxonomic work has been carried out for the mosses but is lacking for most macrofungal families and genera.

At the species and site specific levels there are very few conservation plans with any focus on cryptogamic taxa. There are 1248 and extant plants listed as threatened federally (Department of the Environment and Water Resources 2007b) and 457 for Tasmania (Department of Primary Industries and Water 2007c). These figures include a single moss which is listed federally (DEWR 2007a) and a single moss listed for Tasmania (DPIW 2007b). Also, there are 38 communities listed as threatened federally (DEWR 2007a) and 39 for Tasmania (DPIW 2007a). One of these listed Tasmanian communities is a type of *Sphagnum* peatland, which is considered rare. For the fungi in Australia, ten species and a single waxcap (Hygrocybeae) community have been listed as threatened in New South Wales (Buchanan & May 2003).

Strategies for cryptogam conservation

There is a very limited awareness of cryptogams among the general public and decision-makers (Scott *et al.* 1997; Hylander 2007). Conservation planning for cryptogams therefore has been very limited (Scott *et al.* 1997; Moore *et al.* 2001; Hylander 2007). Lack of data about cryptogams is probably the largest limitation to their conservation at the moment (Hawksworth 1991, 1997; Scott *et al.* 1997; Hallingback & Hodgetts 2000; Entwistle 2003; Hallingback 2007; Hylander 2007).

Conservation biologists have recognised that conservation efforts need to be managed at different spatial scales (Shafer 1990; Primack 1993; Groves *et al.* 2000; Poiani *et al.* 2000). Common species can usually be managed at bioregional or landscape scales, while uncommon species require specific conservation efforts (Poiani *et al.* 2000). Given the limited data on the distribution of cryptogams, a species specific approach is rarely possible with current data sets. For this reason some authors have suggested using a higher-taxon approach for the conservation planning of mega-diverse groups like the macrofungi (Balmford *et al.* 2000). Others have suggested a phylogenetic approach to diversity conservation (Faith 1995; Barker 2002; Faith *et al.* 2004b; Posadas *et al.* 2004; Villasenor *et al.* 2005).

Species have frequently been used as surrogates or indicators of many factors including biodiversity, environmental variables, ecosystem health and/or function (Noss 1999; Diekmann 2003; Duelli & Obrist 2003; Ewald 2003; Kollmann & Fischer 2003; Michaels 2007). In Europe, indicator (or 'signal') species, many of which are cryptogams, have been used to try and identify sites which are likely to contain Red List species (Gustafsson *et al.* 1999; Gustafsson *et al.* 2005; Norden *et al.* 2007). Indicator species have also been used to try and find areas important for biodiversity (Pearson 1995; Faith & Walker 1996b). Although this approach has often been used successfully, care needs to be taken to use appropriate species (Caro & O'Doherty 1999; Lindenmayer *et al.* 2000; Duelli & Obrist 2003; Saetersdal *et al.* 2005; Favreau *et al.* 2006).

Conservation strategies not based on species are environmental domain, habitat and forest-structural approaches. An approach which is not dependent on biotic data, is the Environmental Diversity (ED) strategy or environmental domain approach (Kirkpatrick & Brown 1994; Faith & Walker 1996a; Faith 2003; Faith *et al.* 2004a). Smith *et al.* (2001) advocated the conservation of populations across environmental gradients to maximise adaptive diversity. Another approach to conservation for cryptogams which does not rely specifically on species data is the habitat approach (Berg *et al.* 1994; Scott *et al.* 1997;

Hallingback & Hodgetts 2000; Buchanan & May 2003; Hallingback 2007). Habitat protection is fundamental to the European conservation effort (Natura 2000 2007) and fits well with the ecosystem approach (Convention on Biological Diversity 2000).

The European habitat system is largely defined by vegetation. The habitat approach also has been recommended for other cryptic groups like invertebrates (Hughes *et al.* 2000). Newmaster *et al.* (2005) highlighted the need to identify and then conserve specific microhabitats at a landscape scale in order to conserve rare bryophyte taxa which often have specific habitat requirements. One of the problems with habitat approaches is that currently vegetation data is one of the main surrogate data sets on which habitats are defined (Miller 2000; Araujo *et al.* 2004). The success of habitat approaches depends on careful use and interpretation of habitat definitions (Jackson 2000) and research into the usefulness of reserves for all groups (Gustafsson *et al.* 1999). A similar approach suggested for forest management is to use structure-based indicators as tools to identify locations where conservation could enhance biodiversity (Lindenmayer *et al.* 2000).

Many cryptogams have particular associations with substrate (McAlister 1997; Bates 2000; Cleavitt 2001; Turner & Pharo 2005). Both of the habitat and structural approaches just mentioned are likely to be successful if they can predict and conserve substrates important for cryptogams. Diversity of woody elements, particularly large old wood, have been cited as priorities for cryptogam conservation (McAlister 1997; Kruys *et al.* 1999; Qian *et al.* 1999; Mills *et al.* 2001; Tedersoo *et al.* 2003; Mills & Macdonald 2004; Norden *et al.* 2004). Rock and soil characteristics also have been shown to affect the distributions of cryptogams (van der Heijden *et al.* 1999; Botting & Fredeen 2006; Anderson *et al.* 2007; Virtanen & Oksanen 2007).

There are a number of stages at which surrogates may be used in conservation planning. For example the seven-step conservation planning framework has been put forward to identify priority areas for

conservation (Groves *et al.* 2002). There are a number of steps in this or similar frameworks in which data for biotic and abiotic elements are used. These are the stages where surrogates for data poor groups may be used.

Surrogates in conservation planning and management

Conservation aims to retain and protect as much biodiversity as possible. Many early conservation efforts were focused on preventing the extinction of rare, often charismatic, species (Noss 1983). The importance of conservation has increased since it was perceived that global biodiversity and the complex interactions of species are essential to ecosystem function (Noss 1990; Raven 1991; Walker 1992; Primack 1993; Hooper *et al.* 2002; Petchey & Gaston 2002; Petchey 2003; Chapin 2004; Duffy *et al.* 2007). For groups where data are limited, planners look for alternatives like surrogates. Surrogates are used on the assumption that, if there is a relationship between groups or species with sufficient data and groups with limited data, these groups or species with sufficient data may be used as predictors of the data poor groups or species.

Using already available data as surrogates is attractive to management as this is less costly than new surveys. For example, for most parts of the world there are geologic and topographic maps, and weather records. Broad vegetation information, usually in the form of maps, is now also available for most landscapes. Tasmania has six or seven vegetation classes at the formation level (Jackson 1965; Kirkpatrick & Dickinson 1984). In Tasmania, vegetation has been mapped for the whole state in a database called TASVEG (Harris & Kitchener 2005), which is principally based on units identifiable from aerial photography, previous mapping and literature (Kirkpatrick 1990), including the forest vegetation mapped under the Regional Forest Agreement (Tasmanian Public Land use Commission and Commonwealth Forest Taskforce 1996), and with some ground truthing. The usefulness of such data is affected by scale and original data quality. Cryptogams are rarely recorded as part of routine

ecological survey or mapping, with the exception of the moss *Sphagnum*, which is included in many large scale vegetation mapping systems (Kirkpatrick *et al.* 1995; Elkington *et al.* 2002), although often only at a generic level (Whinam *et al.* 2001).

Surrogate species are an attractive management tool as management based on a limited number of species reduces the amount of time, money and data that is required for obtaining multi-species or community inventory data (Caro & O'Doherty 1999). An assumption about surrogate species is that management of a limited number of species will allow successful management of all the species in the ecosystems that the surrogate species represent. One problem when using surrogate species for conservation is the confusion caused by inaccurate use of the term 'surrogate species', which has been used to mean indicator species, umbrella species and keystone species (Caro & O'Doherty 1999; Favreau *et al.* 2006). Choosing the right species for the particular task is critical for success.

The determination of species richness for all groups is expensive, time consuming and difficult for cryptic taxa (Magurran 2004). There has been much focus on conservation in areas where species richness is relatively high; so called biodiversity hot-spots (Prendergast *et al.* 1993; Neitlich & McCune 1997; Virolainen *et al.* 2000; Gjerde *et al.* 2004; Odor *et al.* 2006). Simply conserving areas which have high species richness will fail to protect areas which have low species richness but confer important ecosystem services (O'Connor *et al.* 2003; Molnar *et al.* 2004). Conservation of biodiversity hotspots as a strategy on its own has limitations, as species-rich areas frequently do not coincide for different taxonomic groups, and many rare species occur in areas of relatively average or low species richness (Prendergast *et al.* 1993; Faith & Walker 1996b; Smith *et al.* 2001; Orme *et al.* 2005; Lamoreux *et al.* 2006). Even where complementary, the use of hotspots has been shown to have a tendency to select marginal populations (Araujo & Williams 2001).

It has been suggested that biotic groups like plants be used as surrogates for other biotic groups. Cross-taxon studies on species richness and rarity have met with both successes (Ingerpuu *et al.* 2001; Negi & Gadgil 2002; Warman *et al.* 2004a; Villasenor *et al.* 2005; Pawar *et al.* 2007), and failures (Michaels & Mendel 1998; Berglund & Jonsson 2001; Gjerde *et al.* 2004; Chiarucci *et al.* 2005; Chiarucci *et al.* 2007). These successes from cross-taxon studies have been where the patterns of species richness across taxonomic groups are consistent and positively related.

Understanding cryptogamic distributions

A number of Australian studies have investigated bryophyte and lichen distributions in relation to vegetation. Kantvilas and Jarman (1993) found that Tasmanian rainforest cryptogam assemblages are highly distinctive, such that many rainforest cryptogam species were found in a highly isolated and small rainforest fragment. Jarman and Kantvilas (1995a) found that there was good congruence between rainforest type and bryophyte and lichen distributions. Jarman & Kantvilas (1994) found that bryophytes and lichens contributed more to the species richness of sites than the vascular plants and that vascular plant richness was an unreliable indicator of total plant species richness, although the study only considered two eucalypt forest sites and one rainforest site. Pharo *et al.* (1999) found that in lowland forests located in central New South Wales, fern species richness had a strong positive correlation with bryophyte species richness but was negatively correlated with lichen species richness. However, species richness between plants and bryophytes was found to have an inverse relationship in grassy woodlands in Tasmania, with sites of high plant richness having lower bryophyte richness (Pharo *et al.* 2005). Such understanding of the different patterns of cryptogam distributions contributes information for their conservation.

Endemic species, which may be locally abundant, have a tendency to be rare at larger scales (Gaston 1994; Lamoreux *et al.* 2006). Although endemic species and their distributions are important components of a

comprehensive conservation strategy (Bonn *et al.* 2002; Wilson *et al.* 2005), reserve networks also need to consider issues like relative threat and common species. Many conservation planners recognize that scale is important (Pearson & Carroll 1999; Warman *et al.* 2004b; Wilson *et al.* 2005). In most conservation planning systems, conservation is based on broad scales for common species and specific sites/areas for less common species (Groves *et al.* 2000; Poiani *et al.* 2000; Hunter 2002; Hunter 2005).

Many authors, although recognizing that species data are important in conservation planning (Brooks *et al.* 2004), suggest that, if functional ecosystems are to be conserved, issues beyond those of species - like threats, landscape scale processes, ecosystem services, global diversity patterns and community patterns - are important (Faith 1995; Costanza 2000; Barker 2002; O'Connor *et al.* 2003; Cowling *et al.* 2004; Faith *et al.* 2004b; Kati *et al.* 2004; Molnar *et al.* 2004; Su *et al.* 2004). Changes in community composition ('beta-diversity') between locations are another important aspect of biodiversity (Lee & La Roi 1979; Pharo *et al.* 1999; Qian *et al.* 1999; McKnight *et al.* 2007). Although research into species richness currently dominates the literature, given its limitations as basis for conservation (Orme *et al.* 2005; Fleishman *et al.* 2006; McKnight *et al.* 2007), the present study will focus on compositional (beta diversity) differences and similarities between biotic groups, and species-specific associations with substrate.

The aims and structure of the thesis

This study focuses on two groups of cryptogams - mosses and macrofungi - to test the usefulness of vegetation type, vascular plants and environmental variables, including substrate, as surrogates for cryptogams in achieving satisfactory conservation outcomes. Sites from four vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath) were located in the Hobart region of Tasmania.

Chapter 2 gives the details and the rationales behind the data collection methods and analyses.

Chapter 3 describes species richness and distribution patterns across vegetation types for the vascular plants, mosses and macrofungi. Issues of adequacy of sampling is addressed.

Chapter 4 considers the question of congruence between vegetation types and the composition of the three biotic assemblages: vascular plants, mosses and macrofungi. Congruence will be analysed across the four vegetation types and within wet forest and heathy woodland sites.

Chapter 5 explores the correlation of the three biotic groups with their environmental variables, including substrate. Inter-predictability is considered for the vegetation types and then within the wet forest and heathy woodland vegetation types. This chapter also considers the variation of cryptogam composition across different substrates.

Chapter 6 considers moss and macrofungal species fidelity to specific substrates, including soil, rock, litter, wood, burnt wood, and smooth- and rough-barked buttresses.

Chapter 7 assesses the usefulness of different data sets for the reservation of vascular plants, mosses and macrofungi. Minimum sets of sites are selected based on different subsets of the vascular plants, moss and macrofungal taxa and on different reservation targets (10%, 30% and 100%).

The final chapter will discuss the implications of the results for the conservation of mosses and macrofungi and will suggests further directions for research.

References

Amaranthus, M. P., and D. A. Perry. 1994. The functioning of ectomycorrhizal fungi in the field: linkages in space and time. Plant and Soil **159**:133-140.

Anderson, I. C., B. A. Bastias, D. R. Genney, P. I. Parkin, and J. W. G. Cairney. 2007. Basidiomycete fungal communities in Australian sclerophyll forest soil are altered by repeated prescribed burning. Mycological Research **111**:482-486.

Araujo, M. B., P. J. Densham, and P. H. Williams 2004. Representing species in reserves from patterns of assemblage diversity. Journal of Biogeography **31**:1037-1050.

Araujo, M. B., and P. H. Williams. 2001. The bias of complementarity hotspots toward marginal populations Conservation Biology **15**:1710-1720.

Ashton, D. H. 1986. Ecology of bryophytic communities in mature *Eucalyptus regnans* F. Muell. forest at Wallaby Creek, Victoria. Australian Journal of Botany **34**:107-129.

Balmford, A., A. J. E. Lyon, and R. M. Lang. 2000. Testing the higher-taxon approach to conservation planning in a megadiverse group: the macrofungi. Biological Conservation **93**:209-217.

Barker, G. M. 2002. Phylogenetic diversity: a quantitative framework for measurement of priority and achievement in biodiversity conservation. Biological Journal of the Linnean Society **76**:165-194.

Bates, J. W. 2000. Mineral nutrition, substratum ecology, and pollution. Pages 248-311 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Belnap, J., J. Williams, and J. Kaltenecker. 1999. Structure and function of biological soil crusts. Pages 161-178 in R. T. Meurisse, W. G. Ypsilantis, and C. Seybold, editors. Proceedings of the Pacific Northwest Forest & Rangeland Soil Organism Symposium. US Department of Agriculture Forest Service, Portland, Oregon.

Berg, A., B. Ehnstrom, L. Gustafsson, T. Hallingback, M. Jonsell, and J. Weslien. 1994. Threatened plant, animal and fungus species in Swedish forests: distribution and habitat associations. Conservation Biology **8**:718-731.

Berglund, H., and B. G. Jonsson. 2001. Predictability of plant and fungal species richness of old-growth boreal forest islands. Journal of Vegetation Science **12**:857-866.

Blanks, P. A. M. 1996. The predictive value of ecological vegetation classes for the presence of bryophytes. Honours Thesis, University of Melbourne.

Bonn, A., A. S. L. Rodrigues, and K. J. Gaston. 2002. Threatened and endemic species: are they good indicators of patterns of biodiversity on a national scale? Ecology Letters **5**:733-741.

Botting, R. S., and A. L. Fredeen. 2006. Contrasting terrestrial lichen, liverwort, and moss diversity between old-growth and young second-growth forest on two soil textures in central British Columbia. Canadian Journal of Botany **84**:120–132.

Bougher, N. L., and T. Lebel. 2002. Australian sequestrate (truffle-like) fungi. XII. *Amarrendia* gen. nov.: an astipitate, sequestrate relative of *Torrendia* and *Amanita* (Amanitaceae) from Australia. Australian Systematic Botany **15**:513-525.

Bougher, N. L., and K. Syme 1998. Fungi of Southern Australia. University of Western Australia Press.

Brooker, R. W., F. T. Maestre, R. M. Callaway, C. L. Lortie, L. A. Cavieres, G. Kunstler, P. Liancourt, K. Tielbörger, J. M. J. Travis, F. Anthelme, C. Armas, L. Coll, E. Corcket, S. Delzon, E. Forey, Z. Kikvidze, J. Olofsson, F. Pugnaire, C. L. Quiroz, P. Saccone, K. Schiffers, M. Seifan, B. Touzard, and R. Michalet. 2008. Facilitation in plant communities: the past, the present, and the future. Journal of Ecology **96**:18-34.

Brooks, T., G. A. B. Da Fonseca, and A. S. L. Rodrigues. 2004. Species, data, and conservation planning. Conservation Biology **18**:1682-1688.

Brown, M. J., S. J. Jarman , and G. Kantvilas. 1994. Conservation and reservation of nonvascular plants in Tasmania, with special reference to lichens. Biodiversity and Conservation **3**:263-278.

Brundrett, M. 1991. Mycorrhizas in natural ecosystems. Advances in Ecological Research **21**:171-271.

Buchanan, P. K., and T. W. May. 2003. Conservation of New Zealand and Australian fungi. New Zealand Journal of Botany **41**:407-421.

Buck, W. R., and B. Goffinet. 2000. Morphology and classification of mosses. Pages 71-123 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Buck, W. R., D. H. Vitt, and W. M. Malcolm, editors. 2002. Key to the genera of Australian mosses. Australian Biological Resources Study, Canberra.

Caro, T. M., and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology **13**:805-814.

Convention on Biological Diversity. 2000. Ecosystem Approach. UNEP, CBD. United Nations Environment Programme and Convention on Biological Diversity.

Chan, K. M. A., M. R. Shaw, D. R. Cameron, E. C. Underwood, and G. C. Daily. 2006. Conservation planning for ecosystem services. Public Library of Science Biology **4**:e379.

Chapin, S. 2004. Emerging consensus on biodiversity and ecosystem functioning. Global Ecology and Biogeography **13**:477-477.

Chiarucci, A., F. D'Auria, V. De Dominicis, A. Lagana, C. Perini, and E. Salerni. 2005. Using vascular plants as a surrogate taxon to

maximise fungal species richness in reserve design. Conservation Biology **19**:1644-1652.

Chiarucci, A., F. D'Auria, and I. Bonini. 2007. Is vascular plant species diversity a predictor of bryophyte species diversity in Mediterranean forests? Biodiversity and Conservation **16**:525-545.

Claridge, A. W. 1992. Comment: is the relationship among mycophagous marsupials, mycorrhizal fungi and plants dependent on fire? Australian Journal of Ecology **17**:223-225.

Cleavitt, N. L. 2001. Disentangling moss species limitations: the role of physiologically based substrate specificity for six species occurring on substrates with varying pH and percent organic matter. The Bryologist **104**:59-68.

Colpaert, J. V., and K. K. Van Tchelen. 1996. Mycorrhizas and environmental stress. Pages 109-128 in J. C. Frankland, N. Magan, and G. M. Gadd, editors. Fungi and Environmental Change. Cambridge University Press, Cambridge.

Costanza, R. 2000. The dynamics of the ecological footprint concept. Ecological Economics **32**:341-345.

Cowling, R. M., A. T. Knight, D. P. Faith, S. Ferrier, A. T. Lombard, A. Driver, M. Rouget, K. Maze, and P. G. Desmet. 2004. Nature conservation requires more than a passion for species. Conservation Biology **18**:1674-1679.

Dalton, P. J., R. D. Seppelt, and A. M. Buchanan. 1991. An annotated checklist of Tasmanian mosses. Pages 15-32 in M. R. Banks, editor. Aspects of Tasmanian botany - A tribute to Winifred Curtis. Royal Society of Tasmania, Hobart.

Davis, M., and T. Crosby. 2007. To have and to hold - carbon storage by peatland ecosystems can affect global warming - for better or worse. Perspectives: Research and Creative Activities at Southern Illinois University Carbondale.

Dell, M., and J. Jenkin. 2006. Bryophyte distribution in Blackwood forests of the Otway Ranges, Victoria. The Victorian Naturalist **123**:255-264.

Department of the Environment and Water Resources. 2007. EPBC Act List of Threatened Ecological Communities Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of the Environment and Water Resources, Canberra.

Department of Primary Industries and Water. 2007a. Threatened Native Vegetation Communities List. Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water. 2007b. Threatened Species List - Non-Vascular Plants. Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water. 2007c. Threatened Species List - Vascular Plants. Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of Primary Industries and Water, Hobart.

Diekmann, M. 2003. Species indicator values as an important tool in applied plant ecology - a review. Basic and Applied Ecology **4**:493-506.

Dix, N. J., and J. Webster 1995. Fungal Ecology. Chapman & Hall, Cambridge.

Dorrepaal, E., R. Aerts, J. H. C. Cornelissen, T. V. Callaghan, and R. S. P. van Logtestijn. 2004. Summer warming and increased winter snow cover affect *Sphagnum fuscum* growth, structure and production in a sub-arctic bog. Global Change Biology **10**:93-104.

Department of the Environment and Water Resources. 2007. EPBC Act List of Threatened Flora. Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of the Environment and Water Resources, Canberra.

Duelli, P., and M. K. Obrist. 2003. Biodiversity indicators: the choice of values and measures Agriculture, Ecosystems and Environment **98**:87-98.

Duffy, J. E., B. J. Cardinale, K. E. France, P. B. McIntyre, E. Thébault, and M. Loreau. 2007. The functional role of biodiversity in ecosystems: incorporating trophic complexity. Ecology Letters **10**:522-538.

Eldridge, D. 1994. Distribution of soil lichens in semi-arid rangelands: Some food for thought. Australasian Lichenological Newsletter **35**:10-12.

Eldridge, D. J. 2003. Biological soil crusts - nature's natural soil healers. Pages 1-12 in C. L. Brown, F. Hall, and J. Mill, editors. Plant Conservation - Approaches and Techniques from an Australian Perspective. Australian Network for Plant Conservation, Australia.

Eldridge, D. J., D. Freudenberger, and T. B. Koen. 2006. Diversity and abundance of biological soil crust taxa in relation to fine and coarse-scale disturbances in grassy eucalypt woodland in eastern Australia. Plant and Soil **281**:255-268.

Eldridge, D. J., and T. B. Koen. 1998. Cover and floristics of microphytic soil crusts in relation to indices of landscape health. Plant Ecology **137**:101-114.

Eldridge, D. J., W. S. Semple, and T. B. Koen. 2000. Dynamics of cryptogamic soil crusts in a derived grassland in south-eastern Australia. Austral Ecology **25**:232-240.

Eldridge, D. J., S. Skinner, and T. Entwistle 2003. Survey guidelines for non-vascular plants. Botanic Gardens Trust, Sydney.

Elkington, T., N. Dayton, D. L. Jackson, and I. M. Strachan. 2002. National Vegetation Classification: field guide to mires and heaths. Joint Nature Conservation Committee, Peterborough, UK.

Entwistle, T. 2003. An introduction to the conservation of cryptogams. Pages 1-3 in C. L. Brown, F. Hall, and J. Mill, editors. Plant Conservation - Approaches and Techniques from an Australian Perspective. Australian Network for Plant Conservation, Australia.

Ecologically Sustainable Development Working Group on Biological Diversity. 1991. The Conservation of Biological Diversity as it Relates to Ecologically Sustainable Development. Ecologically Sustainable Development Working Group on Biological Diversity (ESDWGBD) Report of Working Party to the Ecologically Sustainable Development Secretariat, Canberra.

Evans, R. D., and J. R. Johansen. 1999. Microbic crusts and ecosystem processes. Critical Reviews in Plant Sciences **18**:183-255.

Ewald, J. 2003. The sensitivity of Ellenberg indicator values to the completeness of vegetation releves. Basic and Applied Ecology **4**:507-513.

Faith, D. P. 1995. Phylogenetic pattern and the quantification of organismal biodiversity. Pages 45-58 in D. L. Hawksworth, editor. Biodiversity: Measurement and Estimation. Chapman & Hall, London.

Faith, D. P. 2003. Environmental diversity (ED) as surrogate information for species level biodiversity. Ecography **26**:374-379.

Faith, D. P. 2006. Insights from an Australian planning framework for biodiversity and ecosystem services. Public Library of Science Biology **4**:e379.

Faith, D. P., S. Ferrier, and P. A. Walker. 2004a. The ED strategy: how species level surrogates indicate general biodiversity patterns through an 'environmental diversity' perspective. Journal of Biogeography **31**:1207-1217.

Faith, D. P., C. A. M. Reid, and J. Hunter. 2004b. Integrating phylogenetic diversity, complementarity, and endemism for conservation assessment. Conservation Biology **18**:255-261.

Faith, D. P., and P. A. Walker. 1996a. Environmental diversity: on the best possible use of surrogate data for assessing the relative biodiversity of sets of areas. Biodiversity and Conservation **5**:399-415.

Faith, D. P., and P. A. Walker. 1996b. How do indicator groups provide information about the relative biodiversity of different sets of areas?: on hotspots, complementarity and pattern based approaches. Biodiversity Letters **3**:18-25.

Favreau, J. M., C. A. Drew, G. R. Hess, M. J. Rubino, F. H. Koch, and K. A. Eschelbach. 2006. Recommendations for assessing the effectiveness of surrogate species approaches. Biodiversity and Conservation **15**:3949-3969.

Fleishman, E., R. F. Noss, and B. R. Noon. 2006. Utility and limitations of species richness metrics for conservation planning. Ecological Indictors **6**:543-553.

Floyed, A. B., and M. Gibson. 2006. Epiphytic bryophytes of *Dicksonia antarctica* Labill. from selected pockets of Cool Temperate Rainforest, Central Highlands, Victoria. The Victorian Naturalist **123**:229-235.

Gaskin, S., and R. Gardner. 2001. The role of cryptogams in runoff and erosion control on bariland in the Nepal Middle Hills of the southern Himalaya. Earth Surface Processes and Landforms **26**:1303-1315.

Gaston, K. J., editor. 1994. Rarity. Chapman & Hall, Melbourne.

Gates, G., and D. A. Ratkowsky. 2004. A preliminary census of the macrofungi of Mt Wellington, Tasmania - the non-gilled basidiomycota. Papers and Proceedings of the Royal Society of Tasmania **138**:53-59.

Gates, G., and D. A. Ratkowsky. 2005. A preliminary census of the macrofungi of Mt Wellington, Tasmania - the Ascomycota. Papers and Proceedings of the Royal Society of Tasmania **139**:49-52.

Gates, G. M., D. A. Ratkowsky, and S. J. Grove. 2005. A comparison of macrofungi in young silvicultural regeneration and mature forest at the Warra LTER site in the southern forests of Tasmania. Tasforests **16**:127-152.

Gibson, M. 2006. Introducing bryophytes. The Victorian Naturalist **123**:192-194.

Gjerde, I., M. Saetersdal, J. Rolstad, H. H. Blom, and K. O. Storaunket. 2004. Fine-scale diversity and rarity hotspots in northern forests. Conservation Biology **18**:1032-1042.

Grgurinovic, C. A. 1997. Larger Fungi of South Australia. Botanic Gardens of Adelaide and State Herbarium, Adelaide, South Australia.

Grgurinovic, C. A. 2003. The Genus *Mycena* in South-eastern Australia. Fungal Diversity Press and Australian Biological Resources Study, Canberra.

Grgurinovic, C. A., and J. Simpson. 2003. Preliminary survey of the fungi of White Mountains National Park. Pages 27-40 in L. Comben, T. Westacott, and K. Berg, editors. White Mountains Scientific Study Report. The Royal Geographical Society of Queensland Inc., Brisbane.

Groves, C., L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval, and B. Runnels 2000. Designing a geography of hope: a practitioner's handbook for Ecoregional conservation planning. The Nature Conservancy, Washington, DC.

Groves, C. R., D. B. Jensen, L. L. Valutis, K. H. Redford, M. L. Shaffer, J. M. Scott, J. V. Baumgartner, J. V. Higgins, M. W. Beck, and M. G. Anderson. 2002. A seven-step framework for developing regional plans to conserve biological diversity, based upon principles of conservation biology and ecology, is being used extensively by the nature conservancy to identify priority areas for conservation. BioScience **52**:499-512.

Gustafsson, L., L. Applegren, and A. Nordin. 2005. Biodiversity value of potential forest fertilisation stands, as assessed by red-listed and 'signal' bryophytes and lichens. Silva Fennica **39**:191-200.

Gustafsson, L., J. De Jong, and M. Noréng. 1999. Evaluation of Swedish woodland key habitats using red-listed bryophytes and lichens. Biodiversity and Conservation **8**:1101-1114.

Hallingback, T. 2007. Working with Swedish cryptogam conservation. Biological Conservation **135**:334-340.

Hallingback, T., and N. Hodgetts. 2000. Mosses, liverworts, and hornworts. Pages 1-106. Status Survey and Conservation Action Plan for Bryophytes. IUCN/SSC Bryophyte Specialist Group, Gland, Switzerland and Cambridge, UK.

Harris, S., and A. Kitchener 2005. From forest to fjaeldmark- Descriptions of Tasmania's vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania, Hobart.

Hawksworth, D. C., P. M. Kirk, B. C. Sutton, and D. N. Pegler, editors. 1995. Ainsworth and Bisby's Dictionary of the Fungi. CAB International, Wallingford.

Hawksworth, D. L. 1991. The fungal dimension of biodiversity: magnitude, significance and conservation. Mycological Research **95**:641-655.

Hawksworth, D. L. 1997. Orphans in 'Botanical' diversity. Muelleria **10**:111-123.

Hooper, D. U., M. Solan, A. Symstad, S. Diaz, M. O. Gessner , P. K. Buchanan, V. Degrange, P. Grime, F. Hulot, F. Mermillod-Blondin, J. Roy, E. Spehn, and L. van Peer. 2002. Species diversity, functional diversity, and ecosystem functioning in M. Loreau, S. Naeem, and P. Inchausti, editors. Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford University Press, Oxford.

Hughes, J. B., G. C. Daily, and P. R. Ehrlich. 2000. Conservation of insect diversity: a habitat approach. Conservation Biology **14**:1788-1797.

Hunter, M. L. 2005. A mesofilter conservation strategy to completment fine and coarse filters. Conservation Biology **19**:1025-1029.

Hunter, M. L. J. 2002. Fundamentals of Conservation Biology. Blackwell Science, Cambridge, Massachusetts.

Hylander, K. 2007. The conservation ecology of cryptogams. Biological Conservation **135**:311-314.

Ingerpuu, N., K. Vellack, T. Kukk, and M. Partel. 2001. Bryophyte and vascular plants species richness in boreo-nemoral moist forests and mires. Biodiversity and Conservation **10**:2153-2166.

Jackson, D. L. 2000. Guidance on the interpretation of the biodiversity broad habitat classification (terrestrial and freshwater types): definitions and relationship with other habitat classifications. Joint Nature Conservation Council Report No. 307, Peterborough.

Jackson, W. D. 1965. Vegetation in J. L. Davies, editor. Atlas of Tasmania. Lands and Surveys Department, Tasmania, Hobart.

Jarman, S. J., and G. Kantvilas. 1994. Lichens and bryophytes of the Tasmanian World Heritage Area. II. Three forest sites at Pelion Plains. Tasforests **6**:103-120.

Jarman, S. J., and G. Kantvilas. 1995. A floristic study of rainforest bryophytes and lichens in Tasmania's myrtle-beech alliance. Tasmanian NRCP Technical Report No. 14. Wildlife and Heritage and department of the Arts, Sport, the Environment, Tourism and Territories, Canberra.

Jarman, S. J., and G. Kantvilas. 1997. Impacts of forestry operations on cryptogams in Tasmania's eucalypt forests. Stage 1. A preliminary assessment of diversity. Page 51. Commonwealth Department of Primary Industries and Energy, and Forestry Tasmania.

Jarman, S. J., and G. Kantvilas. 2001. Bryophytes and lichens at the Warra LTER site. I. An inventory of species in *Eucalyptus obliqua* wet sclerophyll forest. Tasforests **13**:193-216.

Kantvilas, G., and S. J. Jarman. 1993. The cryptogamic flora of an isolated rainforest fragment in Tasmania. Botanical Journal of the Linnean Society **111**:211-228.

Kantvilas , G., and S. J. Jarman 2004. Lichens and bryophytes on *Eucalyptus obliqua* in Tasmania: management implications in production forests. Biological Conservation **117**:359-373.

Kati, V., P. Devillers, M. Difreme, A. Legakis, D. Vikou, and P. Lebrun. 2004. Testing the value of six taxonomic groups as biodiversity indicators at local scale. Conservation Biology **18**:667-675.

Kellar, C., M. Short, and J. Milne. 2006. Epiphytes on *Nothofagus cunninghamii* and *Eucalyptus regnans* in a Victorian cool temperate rainforest. The Victorian Naturalist **123**:222-229.

Kendrick, B. 2000. The Fifth Kingdom. Mycologue Publications, Canada.

Kirkpatrick, J. B. 1990. A synusia-based mapping system for the conservation management of natural vegetation, with an example from Tasmania, Australia. Biological Conservation **53**:93-104.

Kirkpatrick , J. B. 1999. The characteristics and management problems of the vegetation and flora of the Huntingfield area, southern Tasmania. Papers and Proceedings of the Royal Society of Tasmania **133**:103-113.

Kirkpatrick, J. B., P. Barker, M. J. Brown, S. Harris, and R. Mackie. 1995. The reservation status of Tasmanian vascular plant communities. Pages 1-220 in M. MacDonald, editor. Wildlife Scientific Report. Parks and Wildlife Service, Tasmania, Hobart.

Kirkpatrick, J. B., and M. J. Brown. 1994. A Comparison of direct and environmental domain approaches to planning reservation of Forest higher plant communities and species in Tasmania. Conservation Biology **8**:217-224.

Kirkpatrick, J. B., and K. J. M. Dickson. 1984. Vegetation Map of Tasmania 1:500 000. Forestry Commission, Hobart.

Kollmann, J., and A. Fischer. 2003. Special feature: Vegetation as indicator for habitat quality. Basic and Applied Ecology **4**:489-491.

Kruys, N., C. Fries, B. G. Jonsson, T. Lamas, and G. Stahl. 1999. Wood-inhabiting cryptogams on dead Norway spruce (*Picea abies)* trees in managed Swedish boreal forests. Canadian Journal of Forest Research **29**:178-186.

Lamont, B. B. 1995. Interdependence of woody plants, higher fungi and marsupials in the context of fire. CALMScience Supplement, Pages 151-158.

Lamoreux, J. F., J. C. Morrison, T. H. Ricketts, D. M. Olson, E. Dinerstein, M. W. McKnight, and H. H. Shugart. 2006. Global tests of biodiversity concordance and the importance of endemism. Nature **440**:212-214.

Lawrence, J. F., and R. J. Milner. 1996. Associations between Arthropods and Fungi. Pages 137 – 202 in K. Mallett, and C. A. Grgurinovic, editors. Fungi of Australia 1B - Introduction - Fungi in the Environment. ABRS Australia, Canberra.

Lee, T. D., and G. H. La Roi. 1979. Bryophyte and understory vascular plant beta diversity in relation to moisture and elevation gradients. Vegetatio **40**:29-38.

Lindenmayer, D. B., C. R. Margules, and D. B. Botkin. 2000. Indicators of biodiversity for ecologically sustainable forest management. Conservation Biology **14**:941-950.

Loreau, M. 2004. Does functional redundancy exist? Oikos **104**:606-611.

Loreau, M., S. Naeem, J. Bengtsson, J. P. Grime, A. Hector, D. U. Hooper, M. A. Huston, D. Raffaelli, B. Schmid, D. Tilman, and D. A. Wardle. 2001. Biodiversity and ecosystem functioning: current knowledge and future challenges. Science **294**:804.

Magurran, A. E. 2004. Measuring Biological Diversity. Blackwell Publishing, Carlton.

May, T. W., and J. Avram. 1997. The conservation status and distribution of macrofungi in Victoria. Page 43. A report prepared for the Australian Heritage Commission, Royal Botanic Gardens, Melbourne.

May, T. W., and S. J. M. McMullan-Fisher. 2003. Special issue on Australasian alpine fungi: Introduction. Australasian Mycologist **22**:1-3.

McAlister, S. 1997. Cryptogam communities on fallen logs in the Duke Forest, North Carolina. Journal of Vegetation Science **8**:115-124.

McCarthy, P. M., editor. 2006. Flora of Australia 51 - Mosses 1. ABRS and CSIRO Publishing, Canberra and Melbourne.

McKnight, M. W., P. S. White, R. I. McDonald, J. F. Lamoreux, W. Sechrest, R. S. Ridgely, and S. N. Stuart. 2007. Putting beta-

diversity on the map: broad-scale congruence and coincidence in the extremes. Public Library of Science Biology **5**:e272.

McMullan-Fisher, S. J. M., T. W. May, and P. J. Keane. 2002. The macrofungal community and fire in a mountain Ash forest in southern Australia. Fungal Diversity **10**:57-76.

McMullan-Fisher, S. J. M., T. W. May, and J. B. Kirkpatrick 2003. Some macrofungi from alpine Tasmania. Australasian Mycologist **22**:44-52.

Michaels, K. 2007. Using staphylinid and tenebrionid beetles as indicators of sustainable landscape management in Australia: a review. Australian Journal of Experimental Agriculture **47**:435–449

Michaels, K., and L. Mendel. 1998. Carabid beetles and vegetation associations in the Tasmanian Eastern Tiers: implications for conservation. Pacific Conservation Biology **4**:240-249.

Miller, C. J. 2000. Vegetation and habitat are not synonyms. Ecological Management and Restoration **1**:102-104.

Mills, S., S. E. Macdonald, and D. H. Vitt. 2001. Factors affecting bryophyte species diversity in the boreal forest. Page 20. Pattern and process in Boreal Forest understory. SFM Network Project, Alberta, Canada.

Mills, S. E., and S. E. Macdonald. 2004. Predictors of moss and liverwort species diversity of microsites in conifer-dominated boreal forest. Journal of Vegetation Science **15**:189-198.

Molnar, J., M. Marvier, and P. Kareiva. 2004. The sum is greater than the parts. Conservation Biology **18**:1670-1671.

Moore, D., M. Nauta, S. E. Evans, and M. Rotheroe, editors. 2001. Fungal Conservation - Issues and Solutions. Cambridge University Press and British Mycological Society, Cambridge, UK.

Moore, P. D. 1996. Invertebrates and mycophagy. Nature **381**:372.

Morley, S., and M. Gibson. 2004. Cool Temperate Rainforest Lichens of Victoria, Australia: Floristics and Distribution. The Bryologist **107**:62-74.

Moscal, A., M. J. Askey-Doran, J. B. Kirkpatrick, M. J. Lambourne, P. J. Dalton, and R. Seppelt. 1997. A preliminary assessment of the conservation and reservation status of Tasmanian bryophytes.

Mueller, G. M., and J. P. Schmit. 2007. Fungal biodiversity: what do we know? What can we predict? Biodiversity and Conservation **16**:1-5.

Natura 2000. 2007. Natura 2000 network - Habitats Directive. Page http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm. Europa.

Negi, H. R., and M. Gadgil. 2002. Cross-taxon surrogacy of diversity in the Indian Garhwal Himalaya. Biological Conservation **105**:143-155.

Neitlich, P. N., and B. McCune. 1997. Hotspots of epiphytic lichen diversity in two young managed forests. Conservation Biology **11**:172-182.

Newmaster, S. G., R. J. Belland, A. Arsenault, D. H. Vitt, and T. R. Stephens. 2005. The ones we left behind: comparing plot sampling and floristic habitat sampling for estimating bryophyte diversity. Diversity and Distributions **11**:57 - 72.

Norden, B., H. Paltto, F. Gotmark, and K. Wallin. 2007. Indicators of biodiversity, what do they indicate? - Lessons for conservation of cryptogams in oak-rich forest. Biological Conservation **135**:369-379.

Norden, B., M. Ryberg, F. Gotmark, and B. Olausson. 2004. Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. Biological Conservation **117**:1-10.

Noss, R. F. 1983. A regional landscape approach to maintain diversity BioScience **33**:700-706.

Noss, R. F. 1990. Indicators for monitoring biodiversity: A hierarchical approach. Conservation Biology **4**:355-364.

Noss, R. F. 1999. Assessing and monitoring forest biodiversity: A suggested framework and indicators. Forest Ecology and Management **115**:135-146

O'Connor, C., M. Marvier, and P. Kareiva. 2003. Biological vs. social, economic and potitical priority-setting in conservation. Ecology Letters **6**:706-711.

Odor, P., J. Heilmann-Clausen, M. Christensen, E. Aude, K. W. van Dort, A. Piltaver, I. Siller, M. T. Veerkamp, R. Walleyn, T. Standovar, A. F. M. van Hees, J. Kosec, N. Matocec, H. Kraigher, and T. Grebenc. 2006. Diversity of dead wood inhabiting fungi and bryophytes in semi-natural beech forests in Europe. Biological Conservation **131**:58-71.

Orchard, A. E., editor. 1999. Flora of Australia Volume 1 - Introduction. Australian Biological Resources Study ; CSIRO, Canberra.

Orme, C. D. L., R. G. Davies, M. Burgess, F. Eigenbrod, N. Pickup, V. A. Olson, A. J. Webster, T.-S. Ding, P. C. Rasmussen, R. S. Ridgely, A. J. Stattersfield, P. M. Bennett, T. M. Blackburn, K. J. Gaston, and I. P. F. Owens. 2005. Global hotspots of species richness are not congruent with endemism or threat. Nature **436**:1016-1019.

Packham, J. M., T. W. May, M. J. Brown, T. J. Wardlaw, and A. K. Mills. 2002. Macrofungal diversity and community ecology in mature and regrowth wet eucalypt forest in Tasmania: A multivariate study. Austral Ecology **27**:149-161.

Pawar, S. S., A. C. Biand, M. F. Ahmed, S. Sengupta, and T. R. Shankar Raman. 2007. Conservation biogeography in North-east India: hierarchical analysis of cross-taxon distributional congruence. Diversity and Distributions **13**:53-65.

Pearson, D. L. 1995. Selecting indicator taxa for the quantitative assessment of biodiversity. Pages 75-87 in D. L. Hawksworth, editor. Biodiversity: Measurement and Estimation. Chapman & Hall, London.

Pearson, D. L., and S. S. Carroll. 1999. The influence of spatial scale on cross taxon congruence patterns and prediction of accuracy of species richness. Journal of Biogeography **26**:1079-1090.

Perez, F. L. 1997. Microbiotic crusts in the high equatorial Andes, and their influence on paramo soils. Catena **31**:173-198.

Petchey, O. L. 2003. Integrating methods that investigate how complementarity influences ecosystem functioning. Oikos **101**:323-330.

Petchey, O. L., and K. J. Gaston. 2002. Functional diversity (FD), species richness and community composition. Ecology Letters **5**:402–411.

Pharo, E. J., and A. J. Beattie. 1997. Bryophyte and lichen diversity - a comparative study. Australian Journal of Ecology **22**:151-162.

Pharo, E. J., and A. J. Beattie. 2001. Management forest types as a surrogate for vascular plant, bryophyte and lichen diversity. Australian Journal of Botany **49**:23-30.

Pharo, E. J., and A. J. Beattie. 2002. The association between substrate variability and bryophyte and lichen diversity in Eastern Australian forests. The Bryologist **105**:11-26.

Pharo, E. J., A. J. Beattie, and D. Binns. 1999. Vascular plant diversity as a surrogate for bryophyte and lichen diversity. Conservation Biology **13**:282-292.

Pharo, E. J., A. J. Beattie, and R. L. Pressey. 2000. Effectiveness of using vascular plants to select reserves for bryophytes and lichens. Conservation Biology **96**:371-378.

Pharo, E. J., and P. A. M. Blanks. 2000. Managing a neglected component of biodiversity: a case study of bryophyte diversity in production forests of Tasmania's northeast. Australian Forestry **63**:128-135.

Pharo, E. J., J. B. Kirkpatrick , L. Gilfedder, L. Mendel, and P. A. M. Turner. 2005. Predicting bryophyte diversity in grassland and eucalypt-dominated remnants in subhumid Tasmania. Journal of Biogeography **32**:2015-2024.

Pharo, E. J., D. B. Lindenmayer, and N. Taws. 2004. The effects of large-scale fragmentation on bryophytes in temperate forests. Journal of Applied Ecology **41**:910-921.

Poiani, K. A., B. D. Richter, M. G. Anderson, and H. E. Richter. 2000. Biodiversity conservation at multiple scales: functional sites, landscapes, and networks BioScience **50**:133-146.

Posadas, P., D. R. Miranda-Esquivel, and J. V. Crisci. 2004. On words, tests, and applications: reply to Faith *et al.* Conservation Biology **18**:262-266.

Prendergast, J. R., R. M. Quinn, J. H. Lawton, B. C. Eversham, and D. W. Gibbons. 1993. Rare species, the coincidence of diversity hotspots and conservation strategies. Nature **365**:335-337.

Primack, R. B. 1993. Essentials of Conservation Biology. Sinauer Associates, Sunderland, Mass., U.S.A.

Qian, H., K. Klinka, and X. H. Song. 1999. Cryptogams on decaying wood in old-growth forests of southern coastal British Columbia. Journal of Vegetation Science **10**:883-894.

Ratkowsky, D. A. 1982. The bryophytes of the Mt Wellington Range, Tasmania. Papers and Proceedings of the Royal Society of Tasmania **116**:97-115.

Ratkowsky, D. A., and G. M. Gates. 2002. A preliminary census of the macrofungi of Mount Wellington, Tasmania - the Agaricales. Papers and Proceedings of the Royal Society of Tasmania **136**:89-100.

Ratkowsky, D. A., and G. M. Gates. 2005. An inventory of macrofungi observed in Tasmanian forests over a six-year period. Tasforests **16**:153-169.

Raven, P. H. 1991. Biology in an age of extinction: what is our responsibility? Pages 25-34 in E. C. Dudley, editor. Proceedings of the 4th International Congress of Systematic and Evolutionary Biology. Dioscorides Press, Portland USA.

Reid, J. B., R. S. Hill, M. J. Brown, and M. J. Hovenden, editors 1999. Vegetation of Tasmania. Australian Biological Resources Study, Tasmania.

Risser, P. G. 1995. Biodiversity and ecosystem function. Conservation Biology **9**:742-746.

Robinson, R. M., and N. L. Bougher. 2003. The response of fungi to fire in Jarrah (*Eucalyptus marginata*) and Karri (*Eucalyptus diversicolor*) forests of south-west Western Australia. Pages 269-289 in I. Abbott, and N. Burrows, editors. Fire in Ecosystems of South-west Western Australia: Impacts and Management. Backhuys Publishers, Leiden.

Saetersdal, M., I. Gjerde, and H. H. Blom. 2005. Indicator species and the problem of spatial inconsistency in nestedness patterns. Biological Conservation **122**:305-316.

Schmit, J. P., and G. M. Mueller. 2007. An estimate of the lower limit of global fungal diversity. Biodiversity and Conservation **16**:99-111.

Schofield, W. B. 1985. Introduction to Bryology. Macmillan Publishing Company, New York.

Scott, G., T. Entwistle, T. May, and N. Stevens, editors. 1997. A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi. Environment Australia, Canberra.

Scott, G. A. M., and I. G. Stone 1976. The Mosses of Southern Australia. Academic Press, London.

Selosse, M. 2005. Are liverworts imitating mycorrhizas? New Phytologist **165**:345-349.

Shafer, C. L. 1990. Nature Reserves: Island Theory and Conservation Practice Smithsonian Institution Press Washington, DC.

Singh, J. S. 2002. The biodiversity crisis: a multifaceted review. Current Science **82**:638-647.

Smith, T. B., S. Kark, C. J. Schneider, R. K. Wayne, and C. Moritz. 2001. Biodiversity hotspots and beyond: the need for preserving environmental transitions. Trends in Ecology and Evolution **16**:431.

Su, W., D. M. Debinski, M. E. Jakubauskas, and K. Kindscher. 2004. Beyond species richness: community similarity as a measure of cross-taxon and congruence for coarse-filter conservation. Conservation Biology **18**:167-173.

Syme, K. 1992. Larger fungi of the Two Peoples Bay nature reserve. National Estate Grants Program. Heritage Council of Western Australia, Denmark, WA.

Taylor, R. J. 1992. Reply: Fire, mycorrhizal fungi & management of mycophagous marsupials. Australian Journal of Ecology **17**:227-228.

Tasmanian Public Land use Commission and Commonwealth Forest Taskforce. 1996. Tasmanian-Commonwealth Regional Forest Agreement Background Report. Part C. Environment and Heritage Report Volume II. Tasmanian Public Land Use Commission., Hobart.

Tedersoo, L., U. Koljalg, N. Hallenberg, and K. Larsson. 2003. Fine scale distribution of ectomycorrhizal fungi and roots across substrate layers including coarse woody debrisin a mixed forest. New Phytologist **159**:153-165.

Turner, P. A. M., J. B. Kirkpatrick , and E. J. Pharo. 2006. Bryophyte relationships with environmental and structural variables in Tasmanian old-growth mixed eucalypt forest. Australian Journal of Botany **54**:239-247.

Turner, P. A. M., and E. J. Pharo. 2005. Influence of substrate type and forest age on bryophyte species distribution in Tasmania mixed forest. The Bryologist **108**:67-85.

van der Heijden, E. W., F. W. de Vries, and T. Kuyper, W. 1999. Mycorrhizal associations of *Salix repens* L. communities in succession of dune ecosystems. I. Above-ground and below-ground views of ectomycorrhizal fungi in relation to soil chemistry. Canadian Journal of Botany **77**:1821-1832.

van der Heijden, M. G. A., and I. R. Sanders, editors. 2002. Mycorrhizal Ecology. Springer, London.

van der Maarel, E. 1988. Vegetation dynamics: patterns in time and space. Vegetatio **77**:7-19.

Vernes, K., and D. T. Haydon. 2001. Effect of fire on northern bettong *(Bettongia tropica*) foraging behaviour. Austral Ecology **26**:649-659.

Villasenor, J. L., G. Ibara-Manriquez, J. A. Maeve, and E. Ortiz. 2005. Higher taxa as surrogates of plant diversity in a meagre diverse country. Conservation Biology **19**:232-238.

Virolainen, K. M., P. Ahlroth, E. Hyvarinen, E. Korkeamaki, J. Mattila, J. Paivinen, T. Rintala, T. Suomi, and J. Suhonen. 2000. Hot spots, indicator taxa, complementarity and optimal networks of Taiga Proceedings of the Royal Society of London. Series B, Biological Sciences **267**:1143-1147.

Virtanen, R., and J. O. Oksanen. 2007. The effects of habitat connectivity on cryptogam richness in boulder metacommunity. Biological Conservation **135**:415-422.

Walker, B. H. 1992. Biodiversity and ecological redundancy. Conservation Biology **6**:18 - 23.

Walker, J., editor. 1996. Fungi of Australia 1A Introduction - classification. ABRS Australia CSIRO Publishing, Canberra.

Warman, L. D., D. M. Forsyth, A. R. E. Sinclair, K. Freemark, H. D. Moore, T. W. Barrett, R. L. Pressey, and D. White. 2004a. Species distributions, surrogacy, and important conservation regions in Canada. Ecology Letters **7**:374-379.

Warman, L. D., A. R. E. Sinclair, G. G. E. Scudder, B. Klinkenberg, and R. L. Pressey. 2004b. Sensitivity of systematic reserve selection to decisions about scale, biological data, and targets: case study from southern British Columbia. Conservation Biology **18**:655-666.

Wertheim, B., J. G. Sevenster, I. E. M. Eijs, and J. J. M. Van Alphen. 2000. Species diversity in a mycophagous insect community: the case of spatial aggregation vs. resource partitioning. Journal of Animal Ecology **69**:335-351.

Whinam, J., L. A. Barmuta, and N. Chilcott. 2001. Floristic description and environment relationships of Tasmanian *Sphagnum* communities and their conservation management. Australian Journal of Botany **49**:673-685.

Whittaker, R. J., K. J. Willis, and R. Field. 2001. Scale and species richness: towards a general, hierarchical theory of species diversity. Journal of Biogeography **28**:453-470.

Wilson, K. A., M. F. McBride, M. Bode, and H. P. Possingham. 2005. Prioritizing global conservation efforts. Nature **440**:337-340.

Young, A. M. 1999. The *Hygrocybeae* (Fungi, Basidiomycota, Agaricales, Hygrophoraceae) of the Lane Cove Bushland Park, New South Wales. Austrobaileya **5**:535-564.

Chapter 2 – Methodology

Abstract

Thirty-two sites in four Tasmanian vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath) in the Hobart region were surveyed for vascular plants, mosses and epigeous macrofungi. At each site, a 30 x 30 m quadrat with ten 1 x 5 m strip-plots was randomly placed. To gauge macrofungal quantities at sites, a 30-m central transect was surveyed for 10 minutes at least once per month. When macrofungi were sufficiently abundant, intensive surveys of the strip-plots were conducted. Repeated mycological surveys were carried out during June – December 1999 and February 2001 – May 2003. Vascular plant and moss surveys were carried out once for each site during the survey period. The specific substrate inhabited by mosses and macrofungi was recorded for each taxon. Vascular plant and substrate cover abundances were recorded by using cover abundance classes.

Introduction

This chapter sets out the design of this project and the methods used. Statistical methods that are used in multiple chapters are described. Exploratory analyses and the rationale behind final analytical techniques used elsewhere in the thesis are discussed.

Methods

Study area

The following four vegetation types present in the greater Hobart area were chosen using a vegetation map (Johnson 1994): heathy woodland and alpine heath, wet forest and grassy woodland (Table 1; site locations are shown in Figure 1). Site selection was based on accessibility and incorporated a range of altitudes and soil-fertility levels to provide structural and botanical contrasts (Appendix 1). For example, there were two kinds of heathy vegetation: alpine heath (high-altitude sites of higher

fertility owing to predominantly doleritic substrate) and heathy woodland (low-altitude sites of lower fertility owing to sandstone-dominated substrate). The three lowland communities (heathy woodland, grassy woodland and wet eucalypt forest) covered sites with low rainfall and low nutrient levels (heathy woodland), low rainfall and higher fertility (grassy woodland on dolerite), medium fertility (predominantly on mudstones and siltstones) and higher rainfall (wet forest). Where possible, sites with differing fire histories were chosen to maximise variation in biodiversity.

Table 1. Vegetation code, site name, year of last fire, and vegetation type based on vascular plant surveys using TASVEG categories (Harris & Kitchener 2005). Vegetation code (VC) of the present study: WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

VC	Site	Last fire	Vegetation type
WF	OGA	1967	*Eucalyptus viminalis* wet forest (WVI)
WF	OGB	1967	*E. obliqua* wet forest undifferentiated (WOU)
WF	OGC	1967	*E. obliqua* wet forest undifferentiated (WOU)
WF	OGD	1967	*E. globulus* wet forest (WGL) Or *E. obliqua* wet forest with broad-leaf shrubs (WOB)
WF	OGE	1967	*E. globulus* wet forest (WGL) *E. obliqua* wet forest undifferentiated (WOU)
WF	OGF	1967	*E. globulus* wet forest (WGL) Or *E. obliqua* wet forest undifferentiated (WOU)
WF	ROA	1967	*E. obliqua* wet forest with broad-leaf shrubs (WOB)
WF	ROB	1967	*E. obliqua* wet forest with broad-leaf shrubs (WOB)
WF	ROC	1967	*E. obliqua* wet forest undifferentiated (WOU)
HE	HEA	1988	*E. amygdalina* woodland on sandstone (DAS)
HE	HEB	1988	*E. amygdalina* woodland on sandstone (DAS)
HE	HEC	1996	*E. amygdalina* woodland on sandstone (DAS)
HE	HED	1990	*E. amygdalina* woodland on sandstone (DAS)
HE	HEE	1991	*E. amygdalina* woodland on sandstone (DAS)
HE	HEF	1991	*E. amygdalina* woodland on sandstone (DAS)
HE	HEG	1996	*E. amygdalina* woodland on sandstone (DAS)
GR	GRA	1998	*E. pulchella* woodland (DPU)
GR	GRB	1998	*E. pulchella* woodland (DPU)
GR	GRC	1998	*E. pulchella* woodland (DPU)
GR	GRD	1998	*E. viminalis* grassy woodland (DVG)
GR	GRE	1998	*E. viminalis* grassy woodland (DVG)
GR	GRF	1998	*E. viminalis* grassy woodland (DVG)
MT	MTA	1947	Eastern alpine heathland (HHE)
MT	MTB	1947	Eastern alpine heathland (HHE)
MT	MTC	1947 & 1967	Eastern alpine heathland (HHE)
MT	MTD	1967	Eastern alpine vegetation (HUE)
MT	MTE	1967	Eastern alpine heathland (HHE)
MT	MTF	1967	Eastern alpine heathland (HHE)
MT	MTG	1947 & 1967	Eastern alpine heathland (HHE)
MT	MTH	1967	Eastern alpine vegetation (HUE)
MT	MTI	1967	Eastern alpine vegetation (HUE)
MT	MTJ	1947	Eastern alpine heathland (HHE)

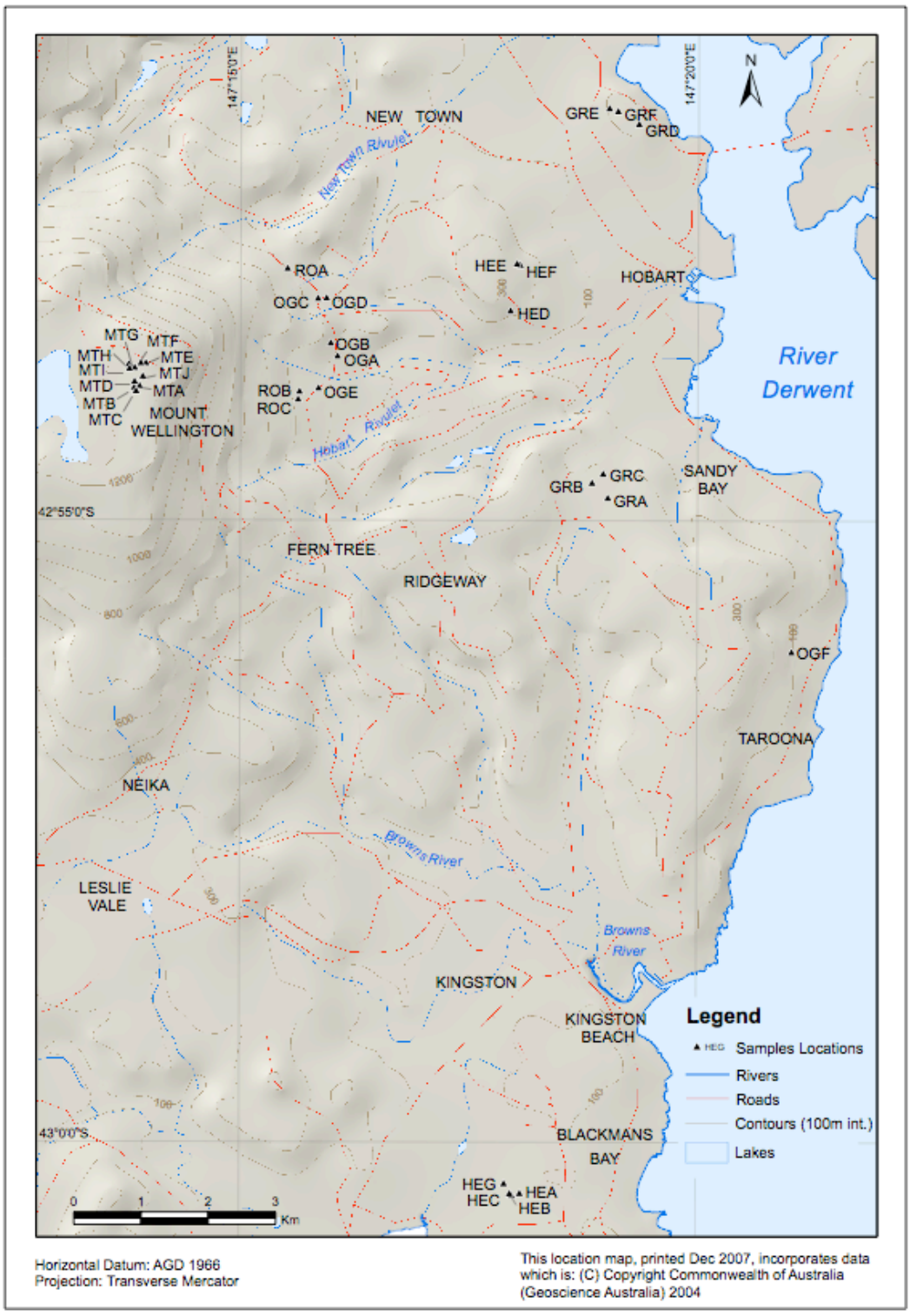


Figure 1. Site locations (site names are listed in Table 1) from the greater Hobart Area, Tasmania (compiled by A. Bender, December 2007).

Environmental characteristics of sites

Geographic coordinates referenced to Australian Geodetic Datum 1966 were recorded with a hand-held GPS, as this was the same datum as current Tasmanian maps. Altitude and geology were recorded from the 1:25000 maps and reports (Appendix 1). Categories used for geology were dolerite, sandstone and mudstone.

Mean annual temperature, and the mean daily minimum and maximum temperatures for the warmest (February) and coldest (July) months were calculated for sites by using altitude and lapse rates for Mount Wellington (Nunez & Colhoun 1986), and the data from the nearest weather station. Hobart Botanical Gardens weather station averages was the nearest weather station for all wet forest sites (OGA-F and ROA-ROC), all grassy woodland sites (GRA-F) and three heathy woodland sites (HED, HEE and HEF). The Kingston weather station averages were used for four heathy woodland sites (HEA-C and HEG). The Mount Wellington weather station averages were used for all alpine heath sites (MTA-J) (BOM 2005). Mean annual rainfall for each site was estimated by using the mean annual rainfall map from (Green & Coughanowr 2003), Figure 6).

Slope and aspect were recorded at the centre of each site with a clinometer. Aspect was later grouped into 5 classes (1 = north-west (292.5–337.5°), 2 = north (0–22.5°, 337.5–0°) or west (247.5–292.5°), 3 = north-east (22.5–67.5°) or south-west (202.5–247.5°), 4 = east (67.5–112.5°) or south (157.5–202.5°), 5 = south-east (112.5–157.5°)). These classes reflect the moisture gradient resulting from solar radiation (Kirkpatrick & Nunez 1980), such that the driest aspect is north-westerly.

Canopy cover of each site was assessed from nine digital photographs of the canopy, taken vertically at 0.5 m above the ground (Figure 2). Images were converted to black and white. The number of dark pixels was calculated as a percentage of all pixels in a circle centred in the middle of each image. These nine percentages were used to calculate a site mean for canopy cover.

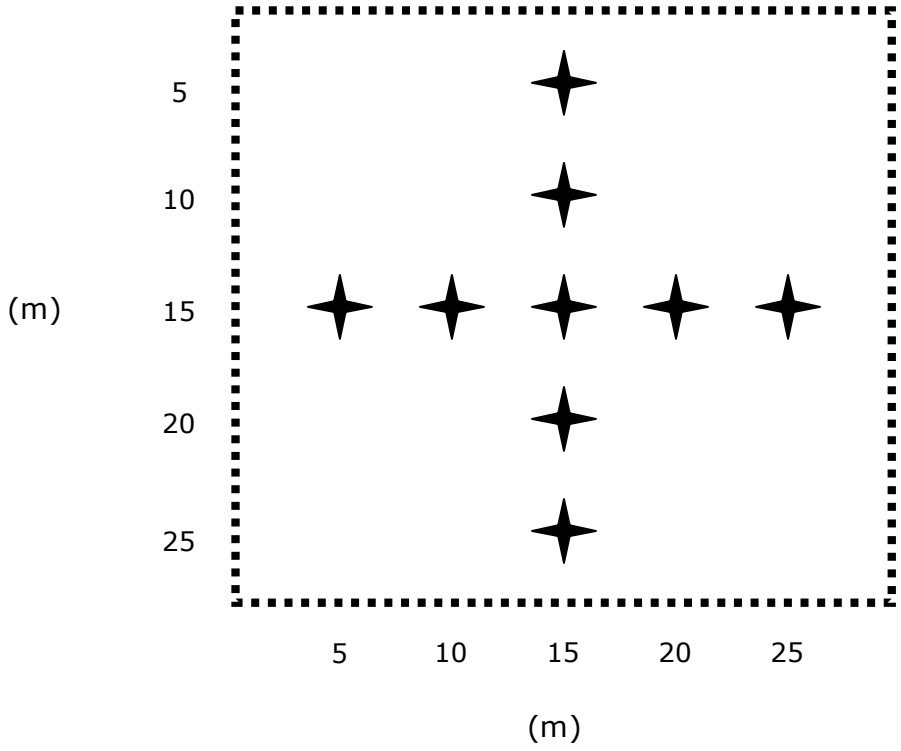


Figure 2. A grid used to photograph canopy cover at each site, ✦ = position of the photograph.

Surveys

Sites and strip-plots

Sites were chosen subjectively without preconceived bias (Mueller-Dombois & Ellenberg 1974), within 50–500 m of a vehicle parking site as they had to be accessed frequently, e.g. fortnightly. A 30 x 30 m (900 m^2) plot was placed at each site (Figure 3). The central transect and strip-plots were parallel to the contours, to allow easy observation. Within this larger plot, ten 1 x 5 m strip-plots were randomly laid out, half either side of a central transect (Figure 3). These strip-plots were numbered from 1 to 10. These strip-plots gave an area of 50 m^2 to be used for intensive surveys. Strip-plots one metre wide were used as these could be surveyed without walking directly within the strip-plot, which could have caused damage from trampling.

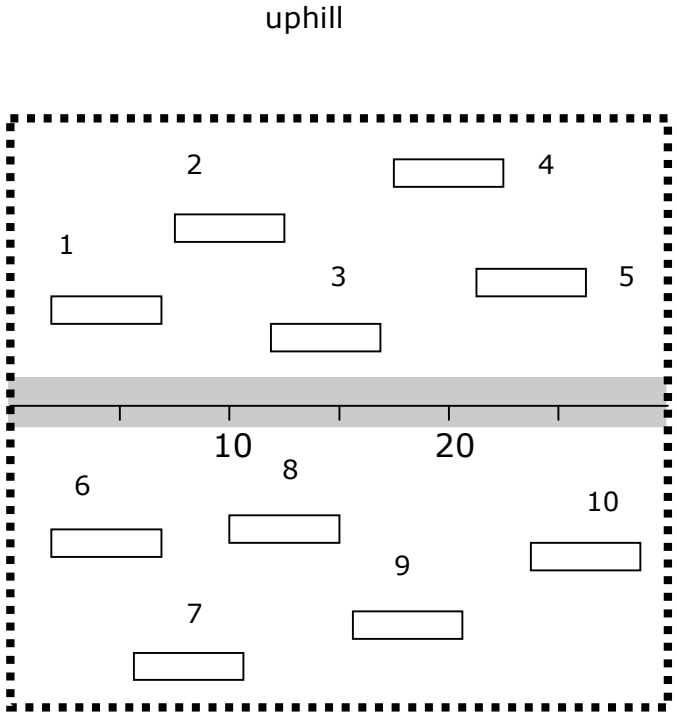


Figure 3. Location of plots and strip-plots. Strip-plots were randomly located. Short survey area included the shaded one metre strip either side of the central transect (distance in metres).

Substrate surveys

All substrates were surveyed by using the ten strip-plots at each site; cover abundance classes were recorded (1 = < 1%, 2 = 1–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%). Many individual substrate types were recognised during data collection of cryptogams. Although these substrates were recorded (Appendix 2), broader substrate classes were used for analyses (Table 2). When cryptogamic cover was recorded, other substrate types, such as soil, logs or buttresses, were also noted. Leaf litter was recorded separately from stick litter. For the most part, leaf litter was made up of *Eucalyptus* and *Acacia* species. Sites were visited a number of times and cover differences of litter for the different vegetation types were recorded, so that these data were known before substrate surveys were carried out. Where a particular plant

species or a group of related species had leaf litter cover of more than 6% for an entire site for that vegetation type, it was recorded separately for each strip-plot of that vegetation type. This occurred with *Allocasuarina* species, *Orites acicularis*, grasses and ferns.

Table 2. Substrate classes

Substrate class	Description
Burnt soil	Soil that has clearly been burnt, i.e. soil is red or black, or contains charcoal
Burnt wood	Wood, including stumps, that has been partially burnt or is entirely charred
Soil	Soil that has not obviously been burnt, and is not covered by moss or litter
Humus	The uppermost layer of the soil, made up of predominantly decomposed organic material
Rock	Exposed rocks
Cryptogamic cover	Cover by mosses, liverworts, hornworts, algae and lichens
Total litter	Dead wood smaller than 1 cm in diameter, dead leaves, bark and dead graminoids in the ground layer
Wood 1–5	Dead wood 1–5 cm in diameter
Wood ≥ 5	Dead wood, including stumps, moss-covered wood and standing wood, equal to or greater than 5 cm in diameter

Vascular plant surveys

Strip-plots at each site were surveyed, noting all angiosperms, gymnosperms and pteridophytes (1 = < 1%, 2 = 1–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%). Any taxa within the site, even if not found in the strip-plots were recorded. Ephemeral taxa, such as orchids, were collected as they appeared during other surveys. Vascular plant observations and identifications were made by JB Kirkpatrick. Vascular plant nomenclature follows (Buchanan 2007). For a list of taxa found at sites, see Appendix 3.

Moss surveys

Mosses were not identified in the field; rather a sample of all bryophytes from different substrates was collected with a knife, and samples were placed into paper bags. This allowed the discovery of smaller mosses, such as *Fissidens* spp., which often grow amongst other bryophytes.

Sample bags were air dried on the day of collection, using a food dehydrator at 30°C. Mosses were surveyed for all sites between August 2002 and January 2003. Lists of taxa found at sites were compiled for further analysis (Appendix 3). The two types of moss survey utilised included short and intensive surveys.

Short moss surveys

Bryophytes found on soil, rock or woody substrates were collected separately for a total of 10 minutes while walking along the 30 m central transect (±1 m). These three substrates were chosen as they were thought to occur in all four vegetation types. The 10 minute period was chosen to be consistent with the timed mycological surveys (see below).

Intensive moss surveys

Mosses were collected from the ten strip-plots. Bryophytes on different substrates (soil, rock, litter, wood, burnt wood, smooth bark and rough bark) were collected separately. Rough bark and smooth bark were used as collection categories, as (Turner 2003) found that bark type influenced the distribution of taxa more than did host species. Bark type was categorised for the lower 2 m of the trunk. Rough bark was defined as bark that was fissured or flaky, or had texture thicker than 1 mm; for species that shed their bark, bark that was in the process of being shed was catagorised as rough. Rough-barked species included *Bedfordia salicina, Coprosma hirtella, Eucalyptus amygdalina, E. globulus*, *E. obliqua, E. viminalis, Exocarpos cupressiformis, E. strictus, Olearia argophylla, Olearia viscosa* and *Pultenaea* spp. Smooth bark was defined as bark that appeared smooth or, when rough, had texture no thicker than 1 mm; for species that shed bark, only the stage that was smooth and firmly attached to trunks was considered smooth. Smooth-barked species included *Acacia dealbata, A. verniciflua, Allocasuarina* spp. (younger trees), *Banksia marginata, Coprosma quadrifida, Pittosporum bicolor* and *Pomaderris apetala*. Bryophytes that occurred on the site but were not observed within strip-plots, were also collected according to

substrate. For example, a large stump might have occurred once on a site; if the stump was not within a strip-plot but had bryophytes, these were collected.

Mycological surveys

A combination of opportunistic, plot-, area- and time-based sampling protocols were used to maximise observation of macrofungal fruit-bodies (Mueller *et al.* 2004). Four types (intensive, short, timed and opportunistic) of mycological survey were utilised and are described below. Individual sampling issues are discussed below. Lists of taxa found at sites were compiled for further analysis (Appendix 3).

Macrofungal taxa observation

Macrofungi include species with readily visible fruiting bodies (typically larger than 1 mm). Only above-ground (epigeous) fungi were sought as searching for sequestrate fungi would have had a destructive effect on the sites as a result of repeated surveys. Disturbed areas in alpine environments may take decades to recover. Substrates were not disturbed more than necessary during surveys. For example, litter was not moved to search for specimens, although all substrate surfaces to a height of 2 m were carefully observed. All macrofungi observed were given a field name. The presence of all macrofungi observed was recorded; however, not all macrofungi were necessarily collected. To reduce the need for collection of specimens for identification, taxa that were recognisable without microscopic confirmation were the focus of this study. Fungimap target taxa were used if possible (Grey & Grey 2005). Groups that had recent taxonomic literature published from Australasia were preferentially collected as it was thought more likely that these groups could be identified to species. These groups were *Amanita, Galerina, Gymnopilus, Hygrocybe, Mycena* and coral fungi. Those taxa not collected were recorded in categories that could be recognised in the field with the highest taxonomic confidence, usually to genus or family level.

Field and laboratory photographs were taken of collected specimens. Photographs were taken with a Canon SLR EOS 500 and a digital Sony-Zeiss DSC-F505V camera used on macro settings. Print images were digitised with a scanner and all images were stored in jpeg format. Images of collected material were identified (see the section on macrofungal identification). Taxa not readily recognisable were 'lumped' together under genus and main characteristics (e.g. *Cortinarius* sp. 'small brown', *Cortinarius* sp. 'dry with violet tints').

Substrate type associated with each macrofungus was recorded (Appendix 2). If a macrofungus was on a number of substrates, all substrates were recorded. For example, if a fungus was found on a log of 40–50 cm in diameter and this log was covered with bryophytes, this information was recorded and later placed in both the wood class and the bryophyte class. The frequency of occurrence of macrofungi on substrates was calculated by considering each new patch of substrate as an observation, rather than by counting individual fruiting bodies (the density and spacing of which can vary for different taxa). For example, a taxon on the same piece of wood or on a patch of leaf litter was in each case considered a single observation. Thus if a taxon was seen on five separate patches of substrate (e.g. five separate logs) it was recorded as having a frequency of five for that site.

Timed mycological surveys

Time-limited surveys were used to gauge macrofungal fruiting so as to predict the optimal times for intensive surveys. Sites were most frequently surveyed for fungal taxa by walking at a slow rate, observing all substrate surfaces, along the central 30 m transect for 10 minutes (Figure 3). Observations were made approximately 1 m to either side of the central transect; these were called *short* surveys. The time taken to photograph and collect specimens was not included in the 10-minute survey period. If the end of the transect was reached before the end of

the 10-minute observation period, the survey continued back along the transect.

From 23 June 1999 to 14 December 1999, the sites ROA, ROB, OGB, OGC, OGF, HEA, HEC, JED, HEE, GRA, GRC, GRD, GRF, MTA, MTE, MTF and MTJ were surveyed fortnightly. The remaining sites were surveyed monthly. During the second survey period (February 2001 – May 2003), the survey was modified by dividing the sites divided into two batches; each batch (including ~50% of the sites) was then surveyed once a month, with the surveys of the two batches on alternating fortnights.

These short surveys were designed to monitor site and community differences, and keep a running list of species and their occurrence on microhabitats. When a fungal 'peak' was recognised, more time-consuming intensive surveys were carried out.

After 2001, alpine-heath and grassy woodland sites were no longer regularly surveyed, in part because of low macrofungal numbers as a result of drought conditions (Bureau of Meteorology 2007), but also owing to a need to reduce the amount of time spent on surveys.

Substantial rainfall occurred in April 2003, granting an opportunity to get more macrofungal data from grassy woodland sites. At these sites, surveys of the entire 900 m^2 were carried out, recording macrofungal observations in 10-minute periods (Table 3). Observations were made by walking at a slow rate, observing all substrate surfaces. Timed surveys were continued until the entire area had been observed and 10 minutes had passed without finding macrofungi. Again the time taken to photograph and collect specimens was not included in the 10-minute survey periods.

Table 3. Number of timed surveys for grassy woodland sites.

Site	Date	Number of 10-minute surveys
GRA	8/4/2003	6
GRB	9/4/2003	4
GRC	9/4/2003	3
GRD	8/4/2003	4
GRE	9/4/2003	4
GRF	9/4/2003	3

Intensive mycological surveys

Intensive surveys were carried out during fungal peaks as gauged by short surveys. At each site, the strip-plots were surveyed for all macrofungal taxa present. Taxa not seen in strip-plots, but seen within the 900-m^2 site, were also recorded. Observations of macrofungi were so rare in alpine heath and grassy woodland that short surveys did not trigger intensive surveys for macrofungi on these sites. Rather, surveys for macrofungi were carried out during surveys of the strip-plots for vascular plants, mosses and substrates.

Opportunistic mycological surveys

While walking to sites, macrofungal taxa and their substrate type were recorded from the vegetation type, to gauge whether a site was relatively representative of the vegetation type. Macrofungi were also recorded for sites whilst carrying out surveys for substrate, vascular plants and mosses.

Identification of cryptogam taxa

Moss identification

Mosses were sorted under the stereo-light microscope and identified by the use of stereo-light and compound microscopes. Wherever possible a voucher specimen was prepared of each taxon from each vegetation type and deposited in the Tasmanian Herbarium (HO) and National Herbarium of Victoria (MEL). Mosses were identified from bryophyte samples (Appendix 3). Moss nomenclature follows (Streimann & Klazenga 2002).

Macrofungal identification

Where possible a voucher specimen of each species and each field taxon was collected. Where material suitable for a herbarium specimen was insufficient, e.g. a single, old fruit body, these typically small collections, which were often the only material available at the time, were taken to check the consistency of field identification but have not been lodged in a herbarium. Specimens were dried in a food dehydrator at 30°C. Collections with sufficient material were lodged at Tasmanian Herbarium (HO) and National Herbarium of Victoria (MEL).

In some cases specimens were examined microscopically to confirm initial identification. For basidiomycetes a piece of the gill edge was rehydrated in 5% KOH, gently squashed under a cover slip and examined with a compound microscope (x 100 objective). The size, shape, colour and ornamentation of spores were observed and the presence or absence of cystidia was noted. These characters usually allowed confirmation of the genus. Where relevant, e.g. for *Russula* specimens, a piece of the gill edge also was observed in Meltzers reagent (Singer 1986). A similar process was used for ascomycete specimens, except that thin sections of the apothecium were cut and stained with 5% KOH and Meltzers reagent. Final identification, classifications and descriptions of macrofungi are presented in Appendix 4. Nomenclature follows May *et al.* (2004).

Multivariate analyses

A number of multivariate analyses were employed, in several chapters, to answer questions about the similarity and congruence of biotic and environmental factors. The general background and particulars of the analyses used in various chapters of the thesis are described in detail below. Similarity measures and the association matrices derived were the basis of multivariate analyses. Bray–Curtis was used for the biotic data and Euclidean distance was used for the abiotic data. Ordination, classification and analysis of similarity (ANOSIM) were used to

investigate patterns of similarity within and among the three biotic groups. Mantel tests and Partial Mantel tests were used to compare the associations between the three biotic groups and the environmental variables, including substrate.

Similarity measures

Similarity measures were used to create association matrices which were the basis of further analyses including ordination, classification, ANOSIM and Mantel tests. Bray–Curtis (Sorenson's) was a distance measure used to create matrices for biotic group analyses. Bray–Curtis was used as it is a semi-metric similarity (or dissimilarity) measure, which does not attribute similarity to shared absences (Faith *et al.* 1987; McCune *et al.* 2002; Quinn & Keough 2002). In addition, this measure has been shown to be the best for quadrat-sampled phytosociological data (Faith *et al.* 1987).

The Euclidean distance measure was used to create matrices for environmental factors, substrate factors and geographic distance. Euclidean distance is a metric similarity (or dissimilarity) measure, which is commonly used with environmental factors (McCune *et al.* 2002). The matrices using Euclidean distance were standardised for analysis so that each factor ranged from zero to one for continuous variables. Qualitative factors, such as the geology of sites, were recorded in classes as zero or one for each geology type. Factors were not weighted. Autocorrelation in analyses was investigated using geographic distance. These geographic distance matrices were created by using UTM coordinates. As study sites were within the same UTM zone and thus shared the same origin, the distances between sites were calculated simply by subtracting coordinates. These distances were then standardised relative to each other from zero to one, with zero being closest and one being furthest from the origin. Use of Euclidean distance for the geographic matrices was carried out as the distance matrices were automatically calculated by the statistical package. This step, although time efficient, is redundant at this scale as the geographic distance matrices created by UTM

coordinates are effectively the same as the geographic distance matrices calculated by Euclidean distance.

Ordination

Nonmetric multidimensional scaling (NMDS) is a robust, nonparametric ordination technique (Minchin 1987; McCune *et al.* 2002; Quinn & Keough 2002). Stress plots were used as a guide to select the number of dimensions. Solutions with a stress less than 0.20 are presented.

Classification

Classification analyses were carried out on the vascular plant, moss and macrofungi data sets. Cluster analysis results using Euclidean distance with Ward's method, Bray–Curtis with group average and Bray–Curtis with flexible beta (–0.25) were compared. These methods resulted in similar broad groups but some sites varied in their positions within and among groups. Analyses using group average as a linkage method were prone to chaining. Results from the use of Ward's method showed distinct groups. However, Euclidean distance was used and Bray-Curtis distance measure is preferred for biotic data; therefore, linkage by using flexible beta (–0.25), as suggested by (McCune *et al.* 2002), was used and presented.

Analysis of similarity

Analysis of similarity (ANOSIM) compares the rank similarities for the between-group similarity with the within-group similarity. This allows the testing of *a priori* groups, namely that sites actually matched their vegetation types. ANOSIM tests were carried out by using the ANOSIM routine in PRIMER version 5.2.4 (Clarke & Gorley 2001). The routine was run for 10 000 iterations. It should be noted that ANOSIM does not adjust significance levels of pair-wise tests; consequently, *P*-values near 0.05 should be interpreted with caution (Clarke 1993). ANOSIM produces a test statistic R, which lies within the range –1 to +1. If R = 1, then sites within groups are more similar to each other than to the sites from

other groups. If R = 0, then differences within and among groups are about the same on average. If R < 0, then the differences within groups are greater than the differences among groups.

Mantel and Partial Mantel tests

Mantel and Partial Mantel tests were run with R version 2.5.0 (Gentleman & Ihaka 1997). Distance matrices were created with the Vegan package (Oksanen *et al.* 2007). To ensure that the results did not converge to a local minimum, the analyses were run for 100 000 iterations before a stable solution was accepted. Outputs from these analyses included Spearman rank correlation ρ statistic, *r*-values and confidence intervals (95% results reported).

Analytical errors and their estimation can be difficult to gauge (Quinn & Keough 2002). Although the 95% confidence intervals were calculated for the Partial Mantel tests, it was not possible to estimate exactly what the relative measurement errors would be for the different types of data, e.g. the relative error when using species lists and environmental factors. The following section compares the different correlation values. To allow for unknown error, *r*-values within 0.05 of each other plus twice the 95% confidence interval are assumed to be effectively the same.

Some literature suggests that spatial autocorrelation amongst organisms may have a significant effect where sites are closely located (Legendre & Fortin 1989; Legendre 1993; Urban *et al.* 2002; Diniz-Filho *et al.* 2003). The effect of autocorrelation was investigated by using Mantel and Partial Mantel tests as suggested by Urban *et al.* (2002). A series of Mantel and partial Mantel tests were run to account for the effect of geographic distance and environmental-factors distance, together and separately, on the three biotic assemblages across the four vegetation types (Appendix 5). The results from these series of tests showed a significant result ($P < 0.0001$), such that the differences between *r*-values of equivalent Mantel and Partial Mantel tests were low (*r*-range = 0.03–0.07). Results of these preliminary analyses are presented in Appendix 5. As a conservative

position, it was assumed that spatial autocorrelation effects occur, and such effects were accounted for by running Partial Mantel tests, with stable distance matrix created from the geographic distances between sites.

The macrofungi were surveyed repeatedly, creating an accumulated data set for each site. Although not all macrofungal species would have been found during the survey period, it is assumed that suites of macrofungi found are indicative of sites and that if surveys had been carried out at other times, similar data would have resulted. To check the assumption that surveys of the same sites at different times were correlated, a Partial Mantel test was run comparing the macrofungal data from wet forest and heathy woodland sites between the data collected in 1999 and 2003.

References

Buchanan, A. M. 2007. A census of the vascular plants of Tasmania and index to *The Students Flora of Tasmania*. Tasmanian Museum & Art Gallery, Hobart.

Bureau of Meteorology. 2005. Climate Averages. Page Climatic data averages for Tasmanian weather stations.

Bureau of Meteorology. 2007. Departures from long-term average (anomalies). Page http://www.bom.gov.au/climate/change/amtemp.shtml.

Clarke, K. R. 1993. Non-paramentric multivariate analyses of changes in community structure. Australian Journal of Ecology **18**:117-143.

Clarke, K. R., and R. N. Gorley. 2001. PRIMER version 5.2.4. PRIMER-E Ltd, Plymouth.

Diniz-Filho, J. A. F., L. M. Bini, and B. A. Hawkings. 2003. Spatial autocorrelation and red herrings in geographical ecology. Global Ecology and Biogeography **12**:53-64.

Faith, D. P., P. R. Minchin , and L. Belbin. 1987. Compositional dissimilarity as a robust measure of ecological distance. Vegetatio **69**:57-68.

Gentleman, R., and R. Ihaka. 1997. The R language. Computing Science and Statistics **28**:326–330.

Green, G., and C. Coughanowr. 2003. State of the Derwent Estuary 2003: a review of pollution sources, loads and environmental quality data from 1997-2003. Pages 1-28. The Derwent Estuary Program. Department of Primary Industries, Water and Environment, Hobart.

Grey, P., and E. Grey 2005. Fungi down under. Fungimap, Melbourne.

Harris, S., and A. Kitchener 2005. From forest to fjaeldmark-Descriptions of Tasmania's vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania, Hobart.

Johnson, D. J. 1994. Mapping the vegetation of Hobart: the application of synusiae-based analysis for the purpose of conservation management. Page 176. Masters Thesis Geography and Environmental Studies, University of Tasmania, Hobart.

Kirkpatrick, J. B., and M. Nunez. 1980. Vegetation radiation relationships in mountainous terrain: eucalypt-dominated vegetation in the Risdon Hills, Tasmania Journal of Biogeography **7**:197-208.

Legendre, P. 1993. Spatial autocorrelation: trouble or new paradigms? Ecology **74**:1659-1673.

Legendre, P., and M.-J. Fortin. 1989. Spatial pattern and ecological analysis. Vegetatio **80**:107-138.

May, T. W., J. Milne, A. E. Wood, S. Shingles, R. H. Jones, and P. Neish. 2004. Interactive catalogue of Australian fungi version 2.0 Page http://www.rbg.vic.gov.au/research_and_conservation/fungi/cat. Australian Biological Resources Study, Canberra / Royal Botanic Gardens Melbourne.

McCune, B., J. B. Grace, and D. L. Urban 2002. Analysis of ecological communities. MjM Software Design, Oregon.

Minchin, P. R. 1987. An evaluation of the relative robustness of techniques for ecological ordination. Vegetatio **69**:89-107.

Mueller, G. M., J. P. Schmit, S. M. Huhndorf, L. Ryvarden, T. E. O'Dell, D. J. Lodge, P. R. Leacock, M. Mata, L. Umana, Q. Wu, and D. L. Czederpiltz. 2004. Recommended protocols for sampling macrofungi. Pages 168-172 in Gregory M. Mueller, Gerald F. Bills, and Mercedes S. Foster, editors. Biodiversity of fungi - Inventory and monitoring methods. Elsevier Academic Press, London.

Mueller-Dombois, D., and H. Ellenberg 1974. Aims and methods of vegetation ecology. John Wiley & Sons, Sydney.

Nunez, M., and E. A. Colhoun. 1986. A note on air temperature lapse rates on Mount Wellington, Tasmania. Papers and Proceedings of the Royal Society of Tasmania **120**:11-15.

Oksanen, J. O., R. Kindt, P. Legendre, and B. O'Hara. 2007. Vegan: community ecology package. In 'Ordination methods, diversity analysis and other functions for community and vegetation ecologists'.

Quinn, G. P., and M. J. Keough 2002. Experimental design and data analysis for biologists. Cambridge University Press, Cambridge.

Streimann, H., and N. Klazenga 2002. Catalogue of Australian mosses. Australian Biological Resources Study.

Turner, P. A. M. 2003. The ecology and conservation of bryophytes in Tasmanian wet eucalypt forest. PhD Thesis, Geography and Environmental Studies, University of Tasmania, Hobart, Australia.

Urban, D., S. Goslee, K. Pierce, and T. Lookingbill. 2002. Extending community ecology to landscapes. Ecoscience **9**:200-202.

Chapter 3 – Diversity and distribution results

Abstract

A total of 591 taxa (287 vascular plants, 71 mosses and 233 macrofungi) were recorded across the four vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath). The survey area at each site was sufficient to record most vascular plant and moss taxa for all four vegetation types. For the macrofungi, the strip-plots contained 71%, 73%, 37% and 22% of the taxon richness for the wet forest, heathy woodland, grassy woodland and alpine heath vegetation types respectively. After repeated surveys of the macrofungi, new taxa were still being discovered from wet forest and heathy woodland sites. Numbers of macrofungi observed from the grassy woodland and alpine heath sites were low. These vegetation types seem particularly affected by drought conditions. Taxon richness was highest for the vascular plants in the heathy woodland and grassland sites, while wet forest sites had the highest numbers of taxa of mosses and macrofungi. Similarity indices and taxon distributions show that the four vegetation types have distinctive vascular plant, moss and macrofungal assemblages. Distributions of some taxa were limited to single vegetation types, while other had broader distributions, particularly among the mosses and macrofungi.

Introduction

Understanding diversity and distribution is the basis of most conservation effort (Araujo *et al.* 2004; Chapin 2004; Whittaker *et al.* 2005). The patchy data on moss and, particularly, macrofungal distributions is one of the oft-cited limitations in their conservation (Soderstrom *et al.* 1992; Scott *et al.* 1997; Norris 2003;

Newmaster *et al.* 2005; Hallingback 2007; Hylander 2007; Mueller *et al.* 2007). Several factors conspire to make the identification of cryptogams arduous: their microscopic characters, a scattered and an incomplete literature, and impoverished herbarium collections. Cryptogams often need to be collected for identification. For the macrofungi, literature is often scattered or yet to be produced for Australian taxa. Cryptogam experts are uncommon and many herbaria have limited reference materials and, in many instances, cryptogamic collections data are yet to be made available electronically. For the mosses, species level identification may require sporophore characteristics, which may not be present at the time of collection.

Sampling macrofungi has the additional complication of the ephemeral nature of their reproductive structures (fruit-bodies) (Watling 1995; Lodge *et al.* 2004). The macrofungi are an arbitrary grouping of fungi whose reproductive structures are larger than one millimetre. Although the vegetative portion of fungi may be continually present at a site, their presence can most easily be confirmed by the sighting of the fruit-bodies. Molecular probing is theoretically possible, but is not yet regularly used (Bruns *et al.* 1991; Liesack & Stackebrandt 1992; Gardes & Bruns 1993; Bastias *et al.* 2007; Dickie & FitzJohn 2007). Thus, repeated surveys are needed to determine the local fungal community. Arnolds (1992) suggests that fortnightly sampling for six years should be sufficient to find 100% of macrofungal species from grasslands in Drenthe, The Netherlands. However, studies in other vegetation types have shown continually increasing numbers of macrofungal species over 4-21 years of surveys (Watling 1995; Straatsma *et al.* 2001; Straatsma & Krisai-Greilhuber 2003; Huhndorf *et al.* 2004; Lodge *et al.* 2004; Zak & Willig 2004). Despite these limitations, fungal communities have been recognised from less than optimal survey

times (Villeneuve *et al.* 1991a; Villeneuve *et al.* 1991b; Nantel & Neumann 1992; Iwabuchi *et al.* 1994; Burns & Conran 1997; Wu & Mueller 1997; Guevara & Dirzo 1998; Packham *et al.* 2002; Ratkowsky & Gates 2002; Greslebin & Rajchenberg 2003; Straatsma & Krisai-Greilhuber 2003; Gates & Ratkowsky 2004; Gates & Ratkowsky 2005).

The strategies used in the present study to manage the difficulties of cryptogamic surveys and identification are described. Adequacy of survey efforts is investigated by considering taxon accumulation curves and surveys accumulated over time for the macrofungi. Similarity indices are calculated to compare vegetation types. Taxon richness and typical taxa found for each biotic group, for each of the vegetation types, are reported.

Methods

Taxon accumulation curves

The adequacy of biotic surveys was considered using taxon accumulation curves. Taxon accumulation curves by area were produced for the vascular plants, mosses and macrofungi for each vegetation type by plotting the total number of taxa present in successively larger areas, based on the ten 5 m^2 strip-plots. Finally, the total taxa present on each site was plotted based on the full 900 m^2 site for all surveys.

Macrofungal taxon accumulation curves were produced from the sequence of surveys for each vegetation type. Due to the different survey intervals for the short mycological surveys, different sites had different total numbers of surveys. These macrofungal accumulation curves included data from short, intensive, timed and

opportunistic surveys. To compare the rate of discovery of new macrofungal taxa found on sites across the same survey times, cumulative site totals combining intervening short survey observations with intensive survey periods were produced for all vegetation types except alpine heath. Alpine heath intensive surveys were opportunistically made during vascular plant, bryophyte and substrate surveys. During many of these surveys macrofungi were not observed. The irregularity of these alpine heath macrofungal surveys makes any figure produced from the combination of short and intensive surveys difficult to interpret. Thus, this figure has not been included.

Similarity indices

Three percentage similarity indices were calculated. The Kirkpatrick similarity index was used to check that the assemblages from one vegetation type were not a subset of one of the other vegetation types (Kirkpatrick 1982), while Bray-Curtis and Jaccard's similarity are indices commonly used to compare biodiversity (Magurran 2004).

Kirkpatrick's similarity (Kirkpatrick 1982):

Number of species in common / number of species in smaller flora

Bray-Curtis presence/absence coefficient (Sorensen's similarity) (Magurran 2004):

Number of spp. in common/ ((number of spp. A +number of spp. B)/2)

Jaccard's similarity (Magurran 2004):

Number of species in common / ((total spp. of A + total spp. of B)- spp. in common between A & B))

Results

Five hundred and eighty-eight taxa were recorded from the study sites, comprising 284 vascular plants, 71 mosses and 233 macrofungi (Appendix 3). Moss and macrofungal numbers are an underestimate of diversity as some of the taxa were not identified. Rather, these were grouped at genus or higher taxonomic levels. Mosses and macrofungi contribute more than 51% of the diversity. Examples of moss and macrofungi taxa recorded from the study sites are shown in Figure 1-6.

Taxonomic confidence

The proportion of taxa that were identified to species level or below was 90% for vascular plants, 74% for mosses and only 40% for the macrofungi (Appendix 3). Of the vascular plants, the *Pterostylis longifolia* group consisted of the two more recently described species *Pterostylis melagramma* and *P. williamsonii*. These taxa were grouped as collections were not made; so new names could not be attributed. Other vascular plants not identified to species were a single group at the family level for Orchidaceae and 27 taxa grouped to the genus level.

In addition to the 52 mosses that could be identified to species or infraspecific level, three mosses were considered species level equivalent taxa: *Philonotis* sp. A, Pottiaceae sp. A and *Isopterygium* aff. *minutirameum* (the latter is awaiting confirmation as a newly recorded species for Tasmania). The 26% of mosses not identified to species level or further consisted of 13 taxa identified to at least genus, a complex of species (the *Brachythecium rutabulum/salebrosum* complex), and finally, a single taxon for the *Rosulabryum* aff*. campylothecium* group (*Rosulabryum campylothecium, R. capillare* and *Bryum caespiticium*).

There were 128 macrofungi that could not be assigned to known species. Of these, 26 taxa had strong affinities to named species. In addition, a further 61 taxa were probably undescribed species. Twelve taxa were grouped at the level of genus, a further 18 taxa were considered complexes of described species and 19 taxa were recognisable groups of similar taxa within different genera. Three taxa could only be identified to family level (Corticiaceae spp., Stereales spp. and Strophariaceae spp). Finally, a single group of morphologically similar taxa were lumped and named Agaric spp. I, which were the artificial grouping of all brown, gilled mushroom shaped taxa. For more detailed descriptions of taxa, see Appendix 4.

Species accumulation curves

Area accumulation curves

The 50 m^2 area of the 10 strip-plots was considered sufficient to gauge the richness of the vascular plants (Appendix 6, Figures 1-4) and mosses (Appendix 6, Figures 5-8). Generally a few additional vascular plant and moss taxa were found in the total plot area,

which included short surveys for the mosses. Sites were repeatedly visited during mycological surveys and very few additional vascular plants were found after the initial survey. An exception was *Thismia rodwayi*, a rare plant (Wapstra *et al.* 2005), which was discovered during mycological surveys of site ROA.

Cumulative mycological surveys by area (Appendix 6, Figures 9-12) also showed a reduction in the rate of discovery of new species over the ten strip-plots. The inclusions of sightings within the total 900 m^2 area, from short surveys as well as sightings outside the strip-plots, added a substantial number of macrofungal taxa to each site. In the grassy woodland (20-100%) and alpine heath (40-100%) most of the observed diversity was recorded outside the strip-plots. Taxa observed only from outside the strip-plots were lower for the wet forest (25-40%) and heathy woodland (24-45%).

Repeated macrofungal surveys

For macrofungi, species area curves are based on totals across all visits. Single visits to sites often yielded much lower diversity as shown by taxon-sample accumulation curves (Figures 7-10). Interpretation of these accumulation curves must allow for the unequal numbers of short surveys for sites, which means that survey times do not necessarily match up. The unequal number of surveys arose for four main reasons. The short surveys in the first year for some sites were fortnightly while the rest were monthly, with the following survey periods modified so that each site was visited monthly. Secondly, surveys of grassy woodlands and alpine heath were discontinued at the end of 2001. Thirdly, during a particularly dry spell, once all sites had been visited and no macrofungi found, the following short surveys were limited to a few

of the dampest sites from each vegetation type, reducing time spent surveying. This procedure was continued until rain broke the dry period. Finally, short surveys were suspended once an intensive survey period was started. The efficacy of using short surveys to gauge optimal times to undertake intensive mycological surveys is highlighted by the many short surveys that show no, or few, new fungal taxa (Figures 4-7).

New macrofungal taxa were found at each intensive mycological survey of wet forest and heathy woodland sites (Figure 7 and Appendix 6, Figures 13-14), although the proportion of new taxa found decreased after the first survey period. The May-June 2001 survey period had the highest numbers of new taxa. Heathy woodland sites were not surveyed concurrently with the wet forest sites during July-August 1999, as short surveys of heathy woodland sites indicated relatively low numbers of macrofungi at this time.

Numbers of macrofungi observed from the grassy woodland (Figure 9 and Appendix 6, Figure 15) and alpine heath (Figure 10) sites were particularly low when compared to wet forest and heathy woodland sites (Figures 7-8). Numbers were too low to trigger an intensive mycological survey of grassland sites during the main survey period. Good rainfall in April 2003 prompted timed surveys of grassy woodland sites (Appendix 6, Figure 15).

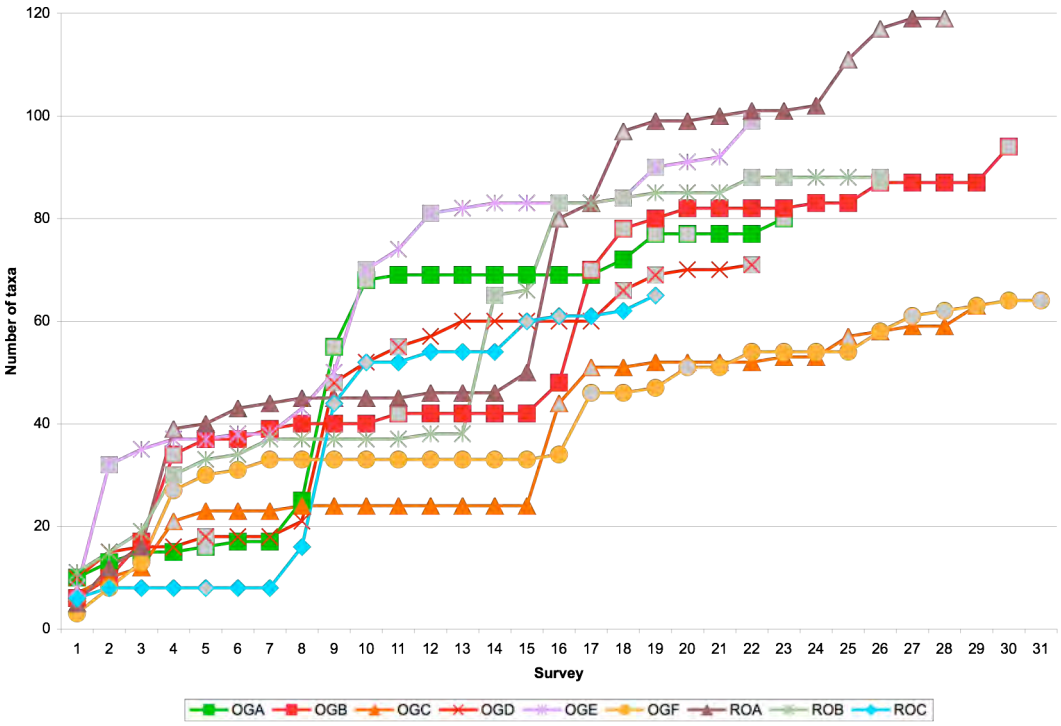


Figure 7. Cumulative numbers of macrofungi from successive surveys of wet forest sites (site names Chapter 2, Table 1). Grey filled symbols indicate intensive surveys, colour filled symbols indicate short surveys.

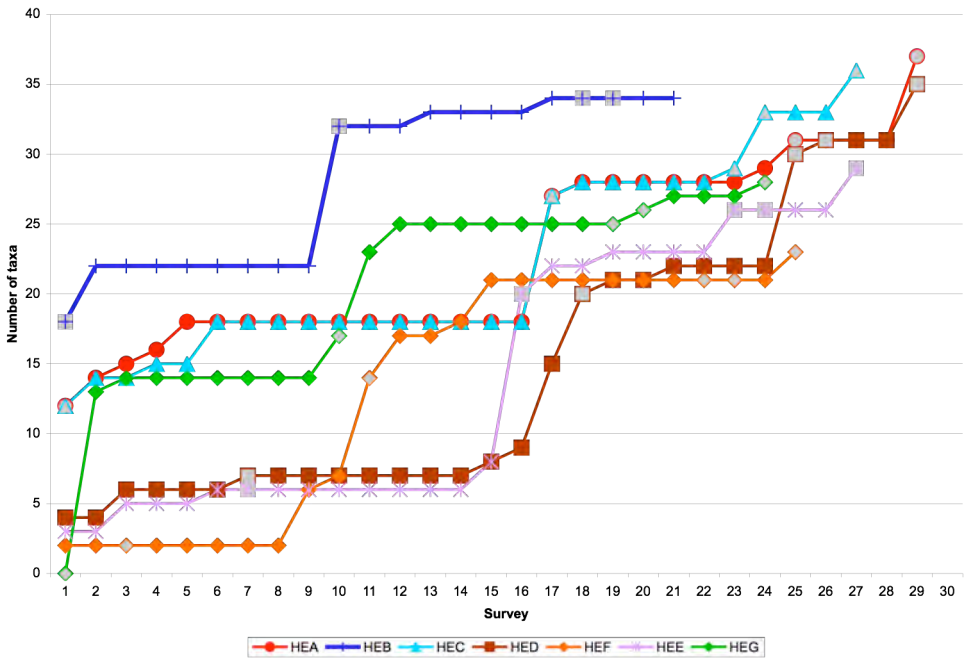


Figure 8. Cumulative numbers of macrofungi from successive surveys of heathy woodland sites (site names Chapter 2, Table 1). Grey filled symbols indicate intensive surveys, colour filled symbols indicate short surveys.

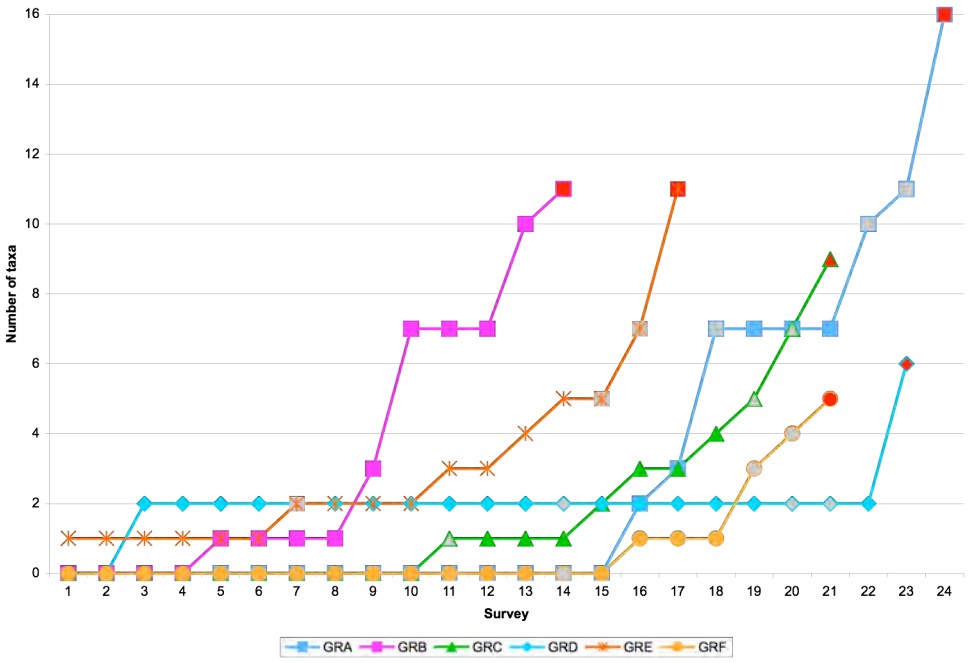


Figure 9. Cumulative numbers of macrofungi from successive surveys of grassy woodland sites (site names Chapter 2, Table 1). Grey filled symbols indicate intensive surveys, red filled symbols are timed surveys and concolorous symbols indicate short surveys.

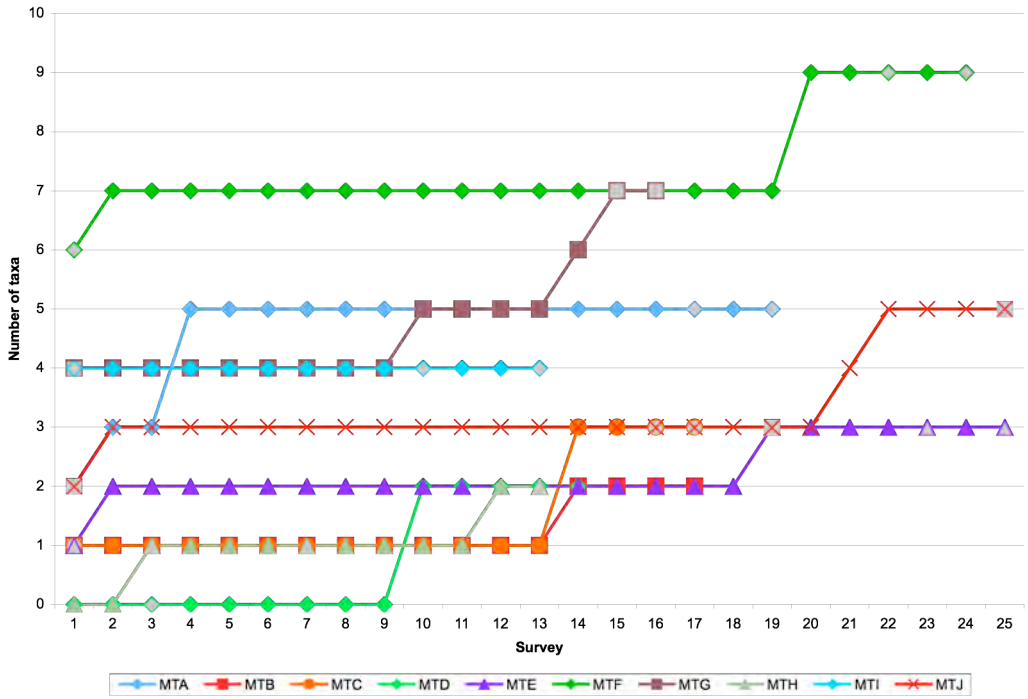


Figure 10. Cumulative numbers of macrofungi from successive surveys of alpine heath sites (site names Chapter 2, Table 1). Grey filled symbols indicate intensive survey and colour filled symbols indicate short survey.

Alpine heath sites had low species-richness of macrofungal taxa (Figure 10). Two of the alpine sites (MTB and MTD) had a total of only two taxa and a third (MTC) had only three taxa. Although species richness was low, macrofungi were present for half of the short surveys (McMullan-Fisher *et al.* 2003). This was due to the frequent occurrence of Discomycete sp. A and *Heterotexus pezizformis*. Snow prevented short surveys six times during the two main survey periods. Of the 30 intensive surveys of alpine sites (each site was surveyed once for vascular plants, bryophytes and substrate) only nine surveys resulted in macrofungal observations. Macrofungal taxa were only observed from sites MTC and MTD during short surveys. Most surveys did not result in new species recorded for sites. For example, four taxa were observed from intensive surveys of sites MTI, yet no more taxa were found despite a further 12 surveys (Figure 10).

The adequacy of biotic surveys was considered using the series of accumulation curves by area. The rate of addition of new species recorded for the vascular plants (Appendix 6, Figures 1-4) and mosses (Appendix 6, Figures 5-8) decreases after 25 square metres is surveyed. A slightly decreased rate of new species discovery was also shown at this area for the macrofungi. However, the accumulation curve for macrofungi did not level off to the same degree as for the other biotic groups (Appendix 6, Figures 9-12). For the macrofungal surveys there is support for the supposition that site surveys at different times are related by the significant Partial Mantel test correlation between the wet forest and heath sites between the data collected in 1999 and 2003 ($p = 0.003$ with Pearson's product-moment correlation with a moderate r-value = 0.36 ± 0.20).

Diversity across vegetation types

Of the four vegetation types, wet forest sites had the highest overall taxon richness (Table 1). This high number is due predominantly to the large number of fungal taxa from wet forest sites (Figure 11). The three other vegetation types combined contained more than 50% of the taxon richness. Overall, mosses contributed least to taxon richness. Heathy woodland sites were highly rich in vascular plants, moderately rich in fungi but had the lowest richness of mosses. Grassy woodland sites had the highest richness of vascular plants and low richness in mosses and fungi. Alpine heath sites had the lowest overall richness, being relatively low in richness for the vascular plants and mosses and particularly low in richness for the fungi.

Table 1. Taxon richness for each vegetation type. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath. The number of sites for each vegetation type is in parentheses.

	WF (9)	HE (7)	GR (6)	MT (10)	Total
Vascular plants	80	103	109	74	284
Mosses	46	15	24	24	71
Macrofungi	204	85	30	16	233
Total	330	203	163	114	588

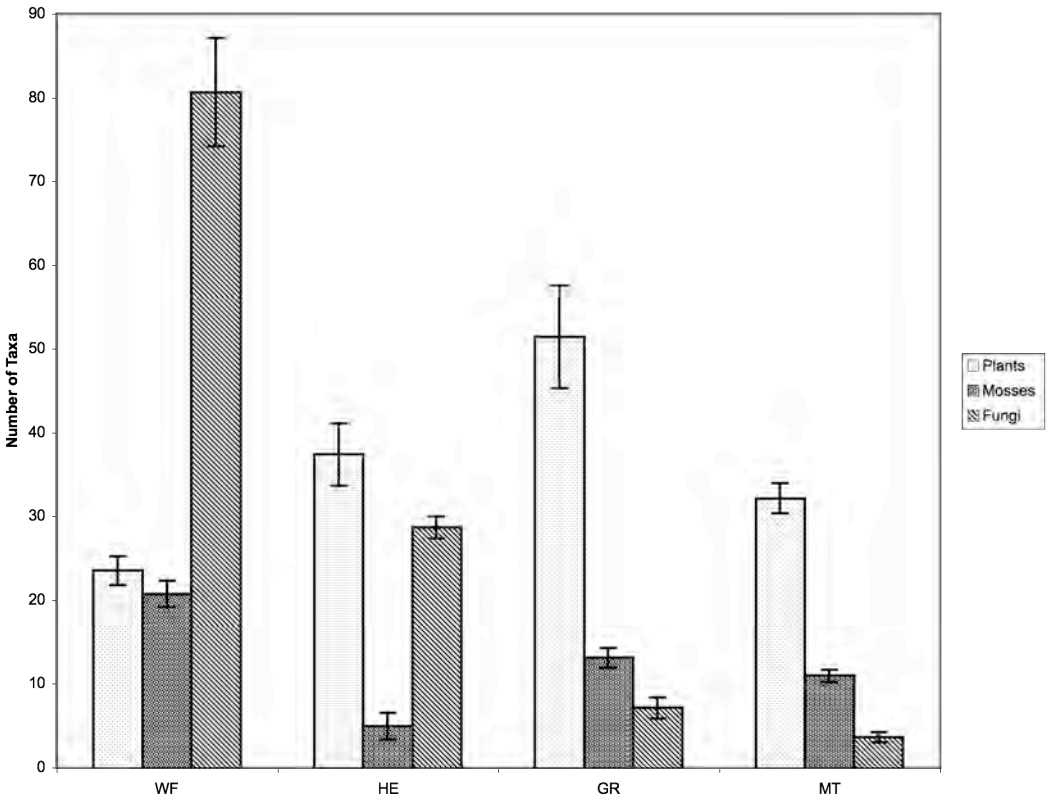


Figure 11. Mean number of taxa for the vascular plants, mosses and macrofungi across the sites within each of the four vegetation types. Bars show standard error. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

None of the vegetation types shared more than half of their taxa with another single vegetation type. Forest and heathy woodland sites had the highest number of shared taxa at 92 with a Kirkpatrick similarity of 0.453 (Table 2-4). The heathy woodland sites seemed to be a subset of the forest assemblage due to the 66% of fungi taxa shared between these vegetation types. The heathy-grassy woodland comparison also had a relatively high similarity of 0.442. The heathy-grassy woodland vegetation similarity was due to 64% of vascular plant taxa shared. The only cryptogams limited to and found in both heathy and grassy woodland sites were the moss *Tortula rubra* and the macrofungi *Bovista* sp. A and *Pycnoporus cinnabarinus*. The wet forest and grassy woodlands showed the next highest similarity with 53

shared taxa relatively evenly distributed across all three biotic groups. Wet forest and alpine sites shared 24 taxa, most (58%) of which were mosses. Alpine heath-heathy woodland sites and alpine heath-grassy woodland vegetation types shared 50% of their mosses. In comparison, there were only twelve vascular plants shared between alpine-heathy and ten vascular plants between alpine-grassy woodland sites. Overall the alpine sites shared the least taxa with the other vegetation types.

Table 2. Number of shared taxa between vegetation types with percentage of shared taxa for vascular plants, mosses, and fungi. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

Comparison	Number of shared taxa	Vascular plants	Mosses	Macrofungi
WF-HE	92	22%	12%	66%
WF- GR	53	40%	25%	36%
WF-MT	24	25%	58%	17%
HE-GR	72	64%	15%	21%
HE-MT	12	17%	50%	33%
GR-MT	10	30%	50%	20%

Comparing all biotic groups, heathy woodland and grassy woodland vegetation had the highest similarity for both Jaccard's and Bray-Curtis indices (Table 3), with values of 0.244 and 0.392 respectively; this pair was the second highest using Kirkpatrick's index. All three indices had wet forest-heathy woodland pairs with high similarity. Pair-wise similarity comparisons which included the alpine vegetation type exhibited lower similarity with most other vegetation types.

Table 3. Pair-wise comparisons between vegetation types using presence/absence data for all biotic groups with three similarity indices. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

	Similarity Index		
Comparison	Kirkpatrick's	Jaccard's	Bray-Curtis
WF-HE	0.453	0.208	0.344
WF- GR	0.325	0.128	0.227
WF-MT	0.210	0.059	0.112
HE-GR	0.442	0.244	0.392
HE-MT	0.105	0.053	0.100
GR-MT	0.088	0.037	0.072

The forest sites had the highest number of taxa restricted to a single vegetation type (Table 4). Among the unique taxa in wet forest sites, the fungi were dominant (65%). For heathy woodland, grassy woodland and alpine heath sites, the vascular plants dominated the unique taxa for each community with 73%, 83% and 79% respectively.

Table 4. Number of taxa found in each vegetation type with percentage unique taxa in parentheses. Also provided is the Total unique taxa for each vegetation type and (in parentheses) this figure as a proportion (%) of the Total taxa. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

	WF	HE	GR	MT
Vascular plants	47 (23%)	51 (73%)	57 (83%)	65 (79%)
Mosses	23 (11%)	2 (3%)	10 (14%)	10 (12%)
Fungi	132 (65%)	17 (24%)	2 (3%)	7 (9%)
Total unique taxa	202 (61%)	70 (34%)	69 (42%)	82 (72%)
Total taxa	330	203	163	114

Vegetation type characterisation

Few taxa were found across all four vegetations types (Appendix 7). The occurrence of taxa across vegetation types was made more likely by the aggregation of some taxa to the level of genus or higher. The moss taxa shared across the four vegetation types consisted of two species, *Ceratodon purpureus* and *Polytrichum juniperinum*, and three groups *Bryum* spp., *Campylopus* spp. and the *Rosulabryum* aff*. campylothecium* group. For the macrofungi,

one species, *Heterotextus peziziformis,* and one group, *Marasmius* spp. II, were present in all four vegetation types.

No vascular plants were common to all four vegetation types (Appendix 7), although eleven of 27 taxa common to wet forest, heathy woodland and grassy woodlands were vascular plants. These species included *Acacia dealbata, Bursaria spinosa, Ehrharta stipoides, Epacris impressa, Eucalyptus globulus, Eucalyptus viminalis, Leptospermum scoparium, Lomandra longifolia*, and *Pultenaea juniperina.* Grouped taxa with the same distribution were *Danthonia* spp. and *Wahlenbergia* spp. The moss species shared by these vegetation types were *Breutelia affinis, Fissidens taylorii, F. tenellus, Rosulabryum billardierei* and *Weissia controversa*. The macrofungal taxa present across the three vegetation types were the individual species *Byssomerulius corium, Fuligo septica, Mycena kuurkacea, Stereum hirsutum, Stereum illudens* and *Trametes versicolor,* plus the grouped taxa Agaric spp. I, *Calocera* spp., *Cortinarius* spp. IV, *Mycena* spp. III and Stereales spp.

Wet forest contained highest taxon richness of the four vegetation types, with 80 of 284 vascular plants, 46 of 71 mosses and 204 of 233 macrofungi (Table 1). Forty-seven vascular plant, 23 moss and 132 macrofungal taxa were restricted to wet forest sites (Appendix 7). Opportunistic surveys within the wet forest types found nine macrofungal taxa not observed from the sites (*Boletellus obscurecoccineus, Cantharellus concinnus, Coltricia cinnamomea, Fistulina hepatica, Ganoderma applanatum, Omphalotus nidiformis, Pseudohydnum gelatinosum*, Stereales spp. and *Scutellina* spp).

Heathy woodland contained 103 of 284 vascular plants, 15 of 71 mosses and 85 of 241 macrofungi (Table 1). Fifty-one vascular plants and 17 macrofungi were restricted to heathy woodland sites

(Appendix 7). The mosses *Barbula calycina*, *Bartramia ithyphylla* and *Pseudoleskea imbricata* were also restricted to heathy woodland, but as these were only found once out of seven sites it was not possible to comment on their distribution other than that they were rare. Opportunistic surveys within the heathy woodland found thirteen further macrofungal taxa that were not observed from the heathy woodland sites: *Amanita xanthocephala, Amanita* sp. A, *Armillaria luteobubalina*, Cortinariaceae sp. A , *Cortinarius abnormis, Cortinarius archeri, Cortinarius rotundisporus, Cortinarius* spp. III, *Descolea recedens, Hygrocybe* sp. B, *Hypholoma fasciculare, Psathyrella* spp. and *Xerula australis*.

Grassy woodlands contained 109 of 284 vascular plants, 24 of 71 mosses and 30 of 241 macrofungi (Table 1). Fifty-seven vascular plants, 10 mosses and 2 macrofungi were restricted to grassy woodlands (Appendix 7). Opportunistic surveys within grassy woodland found two further macrofungal species, *Fomitopsis lilacinogilva* and *Psilocybe subaeruginosa*, which had not been observed from the grassy woodland sites.

Alpine heath sites contained 74 of 284 vascular plants, 24 of 71 mosses and 16 of 241 macrofungi (Table 1). Taxa restricted to alpine sites were 65 vascular plants, 10 mosses and seven macrofungi (Appendix 7). Opportunistic surveys within alpine heath found three macrofungal taxa, *Entoloma* spp. I, *Mycena* sp. B and *Lycoperdon* sp. A, which were not observed from the alpine heath sites.

Discussion

A total of 588 taxa (284 vascular plants, 71 mosses and 233 macrofungi) were recorded across the four vegetation types. This is

a significant dataset despite the difficulties of sampling and identifying cryptograms (discussed below) compared to vascular plants. This is the first comprehensive data set for these four Tasmania vegetation which includes vascular flora, mosses and macrofungi. Other Tasmanian research which includes both vascular flora and cryptogamic data includes rainforest (Jarman & Kantvilas 1995); mixed or eucalypt forest (Packham *et al.* 2002; Turner 2003; Turner *et al.* 2006); and grasslands (Pharo *et al.* 2005). Other work which reports cryptogamic data by vegetation type deals with rainforest (Kantvilas & Minchin 1989; Kantvilas & Jarman 1993; Kantvilas & Jarman 2004); and mixed or eucalypt forest (Ratkowsky 1982; Ratkowsky & Gates 2002; Gates & Ratkowsky 2004; Gates & Ratkowsky 2005). The characterisations of vegetation type from the present study, particularly the moss and macrofungal data, provide useful tools in guiding planning and management decisions for these cryptogams.

A better understanding of distribution of diversity was gained by looking at the distinctiveness of the taxa within each vegetation type. Alpine vegetation has a distinct vascular plant assemblage, but for mosses and fungi there were only a couple of species that were confined to that environment. The wet forest vegetation type also had a large number of distinct taxa, but most were macrofungi. Other than these wet forest mosses and macrofungi there were less vegetation specific cryptogams than vascular plants. This broader distribution of cryptogams has also been noted for both local (May 2002; Moyersoen *et al.* 2003; Munoz *et al.* 2004; Klazenga 2005) and global scales (Scholfield 1985; Bates 2000; Proctor 2000a, b).

In terms of species richness, the wet forest sites had the highest number of mosses and macrofungi but there were relatively few

vascular plants compared to the richness of the vascular plants in the heath and grassy woodland sites. Heath sites had 81 macrofungal taxa and the lowest richness of mosses, with only 15 taxa. The comparatively low number of macrofungi found in heath may be due to the presence of sequestrate (hypogeous) species which are adapted to drier environments (Lebel and Castellano 1999). These fungi were not included in the present study, but are commonly found when appropriate survey techniques, such as raking of soil, are used (Claridge *et al.* 2000a; Claridge *et al.* 2000b). Sequestrate fungi are an important component of the diet of some Australian animals (Claridge 1992; Taylor 1992; Claridge & May 1994; Claridge 1997; Johnson 1997; Green *et al.* 1999; Bougher & Lebel 2001; Vernes *et al.* 2001; Martin 2003; Vernes 2003). Marsupial diggings were observed on the heath sites suggesting that sequestrate fungi maybe present.

Many of the named macrofungal taxa found, particularly those on forest sites, have also been reported from other Tasmanian studies (Packham *et al.* 2002; Ratkowsky & Gates 2002; Gates & Ratkowsky 2004; Gates & Ratkowsky 2005; Gates *et al.* 2005; Ratkowsky & Gates 2005). Most named taxa from the present study were also recorded for the forested slopes of Mt Wellington in the preliminary macrofungal census by Ratkowsky and Gates (Ratkowsky & Gates 2002; Gates & Ratkowsky 2004; Gates & Ratkowsky 2005). Named species found in the present study made up only 33% of the 237 named taxa found by Ratkowsky and Gates (2005), with an additional 16 named species recorded from wet forest sites of the present study. The lower number of species found in the present study is likely to be due to the shorter survey period and the limited area of sites within only four vegetation types. These were a subset of the vegetation types found across Mt. Wellington.

For the wet forest mosses, most taxa were similar to those recorded in earlier work (Ratkowsky 1982; Turner & Pharo 2005) on Tasmanian mosses. About half of the mosses found on heath sites were the same as those found at Huntingfield (Kirkpatrick 1999), some of his sites occur within the study area of this present study. *Bryum argenteum, Ceratodon purpureus, Fissidens taylorii* and *Rosulabryum billardierei* were species typical of grassy woodland sites in this present study that were also found in grassy eucalypt woodlands of eastern Australia (Eldridge *et al.* 2006). The alpine mosses observed in this present study are similar to those observed in the alpine zones of Mt. Wellington and elsewhere in Australasia (Ratkowsky 1982; Ramsay *et al.* 1986).

Data collection strategies and limitations

Short mycological surveys were particularly useful in optimising survey time to periods of higher macrofungal production. The strip-plot area (50 m^2) was more than sufficient to find most vascular plant and moss taxa. For macrofungi, this area had at least 80% of the taxa found on the sites. The accuracy of species richness data was assessed by considering taxon area curves. The results for mosses and vascular plants suggest that a sufficient area was sampled to gauge the species richness at sites. For the macrofungi, the taxon accumulation curves across surveys indicate that many new taxa were being found during intensive surveys, and the curves often did not level off. This suggests that more surveys would be needed to gauge the total species richness of macrofungi at sites, as found by other surveys in various regions across the world (Huhndorf *et al.* 2004; Lodge *et al.* 2004; Straatsma *et al.* 2001; Straatsma & Krisai-Greilhuber 2003; Watling 1995; Zak & Willig 2004).

The four years of macrofungal surveys that were carried out are considered to be sufficient to reflect the underlying ecological patterns. This is supported by the significant correlation found between Partial Mantel tests between the data from wet forest and heathy woodland sites from different years, although the moderate level of the correlation again underlines the need for multiple surveys.

Even though the sampling was thorough there is still potential for error, particularly by not finding taxa that were in fact present on the sites. The use of strip-plots, which delimited a specific narrow area to search, would have increased the chances of recording cryptic taxa. Nonetheless it is possible that some taxa may be present on sites, yet were unrecorded. This is particularly likely for the macrofungi, the sporophores of which are ephemeral, and appear only for short periods of the year after suitable rainfall. To determine the true absences of fungal taxa from sites, DNA sampling techniques for fungal hyphae in soil and other substrates (Horton & Bruns 2001; Dickie & FitzJohn 2007) which allows for molecular profiling of the fungal community (Tedersoo *et al.* 2003; Bastias *et al.* 2006; Tedersoo *et al.* 2006; Anderson *et al.* 2007; Bastias *et al.* 2007; Midgley *et al.* 2007) would be appropriate. However, for identification to species level, such techniques rely on a comprehensive library of the DNA fingerprints of all species likely to occur on the sampled sites, and such information is currently lacking for Australian macrofungi.

Another potential source of error is misidentification. Identification of the taxa in the current study was limited by the lack of comprehensive, recent Australian taxonomic literature. Even though the few cryptogamic researchers were generous with advice and providing draft keys and descriptions for their groups, the lack

of expertise for many groups meant that many species were grouped, mostly at the genus level. The lumping of taxonomically difficult groups was another strategy used to reduce possible identification errors. This strategy was successful and necessary, for without such a strategy the identification process might have taken many years. Despite these identification difficulties, the internal consistency of identification across survey times and sites is considered to be high, due to frequent checking of the microscopic characteristics of many collections. Comparison against other (and future) studies has been made possible by the lodgement of numerous voucher specimens for the macrofungi.

When compared to similar data sets from the northern hemisphere (Gustafsson *et al.* 1999; Kruys *et al.* 1999; Gjerde *et al.* 2004; Jansova & Soldan 2006; Norden *et al.* 2007) in which most cryptogams are identified to species, the Tasmanian data does have some taxonomic limitations. As the data set stands, 90%, 73% and 40% of the vascular plants, mosses and macrofungi respectively were identified to species. There is certainly a trade-off between the comprehensiveness of the data and the time and resources available to collect and identify species. However, the use of taxa grouped at different levels of taxonomic certainty (including species equivalent taxa) produced a satisfactory data set in a reasonable timeframe.

This study was carried out during a period of regional drought (Bureau of Meteorology 2007), so it is likely that moss and macrofungal taxa that require moist conditions were either not recorded or were recorded at lower levels than might have been the case during a wet weather cycle. The particularly low numbers of macrofungi in alpine heath vegetation and also in the grassy woodland may therefore be in part an artefact of lower sampling

effort and in part an effect of the drought. Considering the numbers of alpine macrofungi found in the northern hemisphere (Moser 1982; Watling 1987; Horak 1993), relatively few macrofungi were found on the alpine heath sites of this study. The relatively low numbers of macrofungi seen on grassy woodland sites may have also been affected by the high numbers of graminoids, which are dependent on microfungal arbuscular mycorrhizae (Sylvia *et al.* 1999). Dependence on endomycorrhizae may also be a reason why no ectomycorrhizal macrofungi were observed from the alpine sites in the present study (McMullan-Fisher *et al.* 2003).

The present study is the first time that data on vascular plants, mosses and macrofungi from Australian vegetation have been assembled together to enable testing of associations between the different groups, allowing assessment of assumptions behind the conservation of cryptogams (following chapters). Some considerable challenges of sampling and identification were overcome to produce a large dataset of almost 600 taxa that is considered robust enough to answer ecological questions, even if somewhat incomplete.

References

Anderson, I. C., B. A. Bastias, D. R. Genney, P. I. Parkin, and J. W. G. Cairney. 2007. Basidiomycete fungal communities in Australian sclerophyll forest soil are altered by repeated prescribed burning. Mycological Research **111**:482-486.

Araujo, M. B., P. J. Densham, and P. H. Williams 2004. Representing species in reserves from patterns of assemblage diversity. Journal of Biogeography **31**:1037-1050.

Arnolds, E. 1992. The analysis and classification of fungal communities with special reference to macrofungi in W. Winterhoff, editor. Fungi in Vegetation Science. Kluwer Academic Publishers, London.

Bastias, B. A., I. C. Anderson, Z. H. Xu, and J. W. G. Cairney. 2007. RNA- and DNA-based profiling of soil fungal communities in a native Australian eucalypt forest and adjacent *Pinus elliotti* plantation. Soil Biology and Biochemistry **39**:3108-3114

Bastias, B. A., Z. H. Xu, and J. W. G. Cairney. 2006. Influence of long-term repeated prescribed burning on mycelial communities of ectomycorhizal fungi. New Phytologist **172**:149-158.

Bates, J. W. 2000. Mineral nutrition, substratum ecology, and pollution. Pages 248-311 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Bougher, N. L., and T. Lebel. 2001. Sequestrate (truffle-like) fungi of Australia and New Zealand. Australian Systematic Botany **14**:439 - 484.

Bruns, T., T. White, and J. Taylor. 1991. Fungal molecular systematics. Annual Review Of Ecology And Systematics **22**:525-564.

Bureau of Meteorology. 2007. Departures from long-term average (anomalies). Page http://www.bom.gov.au/climate/change/amtemp.shtml.

Burns, A., and J. G. Conran. 1997. The phenology of macrofungi in relation to autumn rainfall in the Adelaide Hills. Muelleria **10**:95-109.

Chapin, S. 2004. Emerging consensus on biodiversity and ecosystem functioning. Global Ecology and Biogeography **13**:477-477.

Claridge, A., and T. May. 1994. Mycophagy among Australian mammals Australian Journal of Ecology **19**:251-275.

Claridge, A. W. 1992. Comment: is the relationship among mycophagous marsupials, mycorrhizal fungi and plants dependent on fire? Australian Journal of Ecology **17**:223-225.

Claridge, A. W. 1997. Truffle Junkies. Nature Australia **Autumn**:48-55.

Claridge, A. W., S. C. Barry, S. J. Cork, and J. M. Trappe. 2000a. Diversity and habitat relationships of hypogeous fungi. II Factors influencing the occurance and number of taxa. Biodiversity and Conservation **9**:175-199.

Claridge, A. W., S. J. Cork , and J. M. Trappe. 2000b. Diversity and habitat relationships of hypogeous fungi. I Study design, sampling techniques and general survey results. Biodiversity and Conservation **9**:151-173.

Dickie, I. A., and R. G. FitzJohn. 2007. Using terminal-restriction fragment length polymorphism (T-RFLP) to identify mycorrhizal fungi; a methods review. Mycorrhiza **17**:259-270.

Eldridge, D. J., D. Freudenberger, and T. B. Koen. 2006. Diversity and abundance of biological soil crust taxa in relation to fine and coarse-scale disturbances in grassy eucalypt woodland in eastern Australia. Plant and Soil **281**:255-268.

Gardes, M., and T. D. Bruns. 1993. ITS primers with enhanced specificity for fungi and basidiomycetes - application to the identification. Molecular Ecology **2**:113-118.

Gates, G., and D. A. Ratkowsky. 2004. A preliminary census of the macrofungi of Mt Wellington, Tasmania - the non-gilled basidiomycota. Papers and Proceedings of the Royal Society of Tasmania **138**:53-59.

Gates, G., and D. A. Ratkowsky. 2005. A preliminary census of the macrofungi of Mt Wellington, Tasmania - the Ascomycota. Papers and Proceedings of the Royal Society of Tasmania **139**:49-52.

Gates, G. M., D. A. Ratkowsky, and S. J. Grove. 2005. A comparison of macrofungi in young silvicultural regeneration and mature forest at the Warra LTER site in the southern forests of Tasmania. Tasforests **16**:127-152.

Gjerde, I., M. Saetersdal, J. Rolstad, H. H. Blom, and K. O. Storaunket. 2004. Fine-scale diversity and rarity hotspots in northern forests. Conservation Biology **18**:1032-1042.

Green, K., M. K. Tory, A. T. Mitchell, T. T.W, and May. 1999. The diet of the long-footed potoroo (*Potorus longipes*). Australian Journal of Ecology **24**:151-156.

Greslebin, A. G., and M. Rajchenberg. 2003. Diversity of Corticiaceae *sens. lat.* in Patagonia, Southern Argentina. New Zealand Journal of Botany **41**:437-446.

Guevara, R., and R. Dirzo. 1998. A rapid method for the assessment of the macromycota. The fungal community of an evergreen cloud forest as an example. Canadian Journal of Botany **76**:596-601.

Gustafsson, L., J. De Jong, and M. Noréng. 1999. Evaluation of Swedish woodland key habitats using red-listed bryophytes and lichens. Biodiversity and Conservation **8**:1101-1114.

Hallingback, T. 2007. Working with Swedish cryptogam conservation. Biological Conservation **135**:334-340.

Horak, E. 1993. Entoloma in the alpine zone of the Alps: 1. Revision of the taxa described by J. Favre (1955) 2. New records from the Swiss National Park and other locations in the Alps in O. Petrini, and G. A. Laursen, editors. J. Cramer, Berlin.

Horton, T. R., and T. D. Bruns. 2001. The molecular revolution in ectomycorrhizal ecology: peeking into the black-box. Molecular Ecology **10**:1855-1871.

Huhndorf, S. M., D. J. Lodge, C.-J. Wang, and J. N. Stokland. 2004. Macrofungi on woody substrata. Pages 159-163 in Gregory M. Mueller, Gerald F. Bills, and Mercedes S. Foster, editors. Biodiversity of Fungi - Inventory and Monitoring Methods. Elsevier Academic Press, London.

Hylander, K. 2007. The conservation ecology of cryptogams. Biological Conservation **135**:311-314.

Iwabuchi, S., S. Sakai, and O. Yamaguchi. 1994. Analysis of mushroom diversity in sucessional young forest and equilibrium broad-leaved forests. Mycoscience **35**:1-14.

Jansova, I., and Z. Soldan. 2006. The habitat factors that affect the composition of bryophyte and lichen communities on fallen logs. Preslia **78**:67-86.

Jarman, S. J., and G. Kantvilas. 1995. A floristic study of rainforest bryophytes and lichens in Tasmania's myrtle-beech alliance. Tasmanian NRCP Technical Report No. 14. Wildlife and Heritage and department of the Arts, Sport, the Environment, Tourism and Territories, Canberra.

Johnson, C. N. 1997. Short Note: Fire and habitat management for a mycophagous marsupial, the Tasmanian bettong (Bettongia gaimardia). Australian Journal of Ecology **22**:101-105.

Kantvilas, G., and S. J. Jarman. 1993. The cryptogamic flora of an isolated rainforest fragment in Tasmania. Botanical Journal of the Linnean Society **111**:211-228.

Kantvilas , G., and S. J. Jarman. 2004. Lichens and bryophytes on *Eucalyptus obliqua* in Tasmania: management implications in production forests. Biological Conservation **117**:359-373.

Kantvilas, G., and P. R. Minchin. 1989. An analysis of epiphytic lichen communities in Tasmanian cool temperate rainforest. Vegetatio **84**:99-112.

Kirkpatrick, J. B. 1982. Phytogeographical analysis of Tasmanian alpine floras. Journal of Biogeography **9**:255-271.

Kirkpatrick , J. B. 1999. The characteristics and management problems of the vegetation and flora of the Hunting field area, southern Tasmania. Papers and Proceedings of the Royal Society of Tasmania **133**:103-113.

Klazenga, N. 2005. Generic concepts in Australian mosses. Australian Systematic Botany **18**:17-23.

Kruys, N., C. Fries, B. G. Jonsson, T. Lamas, and G. Stahl. 1999. Wood-inhabiting cryptogams on dead Norway spruce (*Picea abies)* trees in managed Swedish boreal forests. Canadian Journal of Forest Research **29**:178-186.

Liesack, W., and E. Stackebrandt. 1992. Unculturable microbes detected by molecular sequences and probes. Biodiversity and Conservation **1**:250-262.

Lodge, D. J., J. F. Ammirati, T. E. O'Dell, and G. M. Mueller. 2004. Collecting and describing macrofungi. Pages 128-158 in Gregory M. Mueller, Gerald F. Bills, and Mercedes S. Foster, editors. Biodiversity of Fungi - Inventory and Monitoring Methods. Elsevier Academic Press, London.

Magurran, A. E. 2004. Measuring Biological Diversity. Blackwell Publishing, Carlton.

Martin, G. 2003. The role of small ground-foraging mammals in topsoil health and biodiversity: Implications to management and restoration. Ecological Management and Restoration **4**:114-119.

May, T. W. 2002. Where are the short-range endemics among Western Australian macrofungi? Australian Systematic Botany **15**:501-511.

McMullan-Fisher, S. J. M., T. W. May, and J. B. Kirkpatrick 2003. Some macrofungi from alpine Tasmania. Australasian Mycologist **22**:44-52.

Midgley, D. J., J. A. Saleeba, M. I. Stewart, A. E. Simpson, and P. A. McGee. 2007. Molecular diversity of soil basidiomycete communities in northern-central New South Wales, Australia Mycological Research **111**:370-378

Moser, M. 1982. Mycoflora of the transitional zone from subalpine forests to alpine tundra. Pages 371-389 in G. A. Laursen, J. F. Ammirati, and S. A. Redhead, editors. Arctic and Alpine Mycology.

Moyersoen, B., R. E. Beever, and F. Martin. 2003. Genetic diversity of *Pisolithus* in New Zealand indicates multiple long-distance dispersal from Australia. New Phytologist **160**:569-579.

Mueller, G. M., J. P. Schmit, P. R. Leacock, B. Buyck, J. n. Cifuentes, D. E. Desjardin, R. E. Halling, K. Hjortstam, T. Iturriaga, K.-H. Larsson, D. J. Lodge, T. W. May, D. Minter, M. Rajchenberg, S. A. Redhead, L. Ryvarden, J. M. Trappe, R. Watling, and Q. Wu. 2007. Global diversity and distribution of macrofungi. Biodiversity and Conservation **16**:37-48.

Munoz, J., A. M. Felicisimo, F. Cabezas, A. R. Burgaz, and I. Martinez. 2004. Wind as a long-distance dispersal vehicle in the southern hemisphere. Science **304**:1061-1192.

Nantel, P., and P. Neumann. 1992. Ecology of ectomycorrhizal-basidiomycete communities on a local vegetation gradient. Ecology **73**:99-117.

Newmaster, S. G., R. J. Belland, A. Arsenault, D. H. Vitt, and T. R. Stephens. 2005. The ones we left behind: comparing plot sampling and floristic habitat sampling for estimating bryophyte diversity. Diversity and Distributions **11**:57 - 72.

Norden, B., H. Paltto, F. Gotmark, and K. Wallin. 2007. Indicators of biodiversity, what do they indicate? - Lessons for conservation of cryptogams in oak-rich forest. Biological Conservation **135**:369-379.

Norris, D. 2003. A conversation about mosses, liverworts and hornworts. Fremontia **31**:5-11.

Packham, J. M., T. W. May, M. J. Brown, T. J. Wardlaw, and A. K. Mills. 2002. Macrofungal diversity and community ecology in mature and regrowth wet eucalypt forest in Tasmania: A multivariate study. Austral Ecology **27**:149-161.

Pharo, E. J., J. B. Kirkpatrick , L. Gilfedder, L. Mendel, and P. A. M. Turner. 2005. Predicting bryophyte diversity in grassland and

eucalypt-dominated remnants in subhumid Tasmania. Journal of Biogeography **32**:2015-2024.

Proctor, M. C. F. 2000a. Moss and alternative adaption to life on land. New Phytologist **148**:1-6.

Proctor, M. C. F. 2000b. Physiological ecology. Pages 225-147 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Ramsay, H. P., H. Streimann, A. V. Ratkowsky, R. Seppelt, and A. Fife. 1986. Australasian alpine bryophytes. Pages 300-335 in B. A. Barlow, editor. Flora and Fauna of Alpine.

Ratkowsky, D. A. 1982. The bryophytes of the Mt Wellington Range, Tasmania. Papers and Proceedings of the Royal Society of Tasmania **116**:97-115.

Ratkowsky, D. A., and G. M. Gates. 2002. A preliminary census of the macrofungi of Mount Wellington, Tasmania - the Agaricales. Papers and Proceedings of the Royal Society of Tasmania **136**:89-100.

Ratkowsky, D. A., and G. M. Gates. 2005. An inventory of macrofungi observed in Tasmanian forests over a six-year period. Tasforests **16**:153-169.

Scholfield, W. B. 1985. Introduction to Bryology. Macmillan Publishing Company, New York.

Scott, G., T. Entwistle, T. May, and N. Stevens, editors. 1997. A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi. Environment Australia, Canberra.

Soderstrom, L., T. Hallingback, L. Gustafsson, N. Cronberg, and L. Hedenas. 1992. Bryophyte conservation for the future. Biological Conservation **59**:265-270.

Straatsma, G., F. Ayer, and S. Egli. 2001. Species richness, abundance and phenology of fungal fruit bodies over 21 years in a Swiss forest plot. Mycological Research **105**:515-523.

Straatsma, G., and I. Krisai-Greilhuber. 2003. Assemblage structure, species richness, abundance, and distribution of fungal fruit bodies in a seven year plot-based survey near Vienna. Mycological Research **107**.

Sylvia, D. M., J. J. Fuhrmann, P. G. Hartel, and D. A. Zuberer 1999. Principles and applications of soil microbiology Prentice Hall, Upper Saddle River, N.J. .

Taylor, R. J. 1992. Reply: Fire, mycorrhizal fungi and management of mycophagous marsupials. Australian Journal of Ecology **17**:227-228.

Tedersoo, L., U. Koljalg, N. Hallenberg, and K. Larsson. 2003. Fine scale distribution of ectomycorrhizal fungi and roots across substrate layers including coarse woody debrisin a mixed forest. New Phytologist **159**:153-165.

Tedersoo, L., T. Suvi, E. Larsson, and U. Kõljalg. 2006. Diversity and community structure of ectomycorrhizal fungi in a wooded meadow Mycological Research **110**:734-748.

Turner, P. A. M. 2003. The ecology and conservation of bryophytes in Tasmanian wet eucalypt forest. Geography and Environmental Studies. University of Tasmania, Hobart, Australia.

Turner, P. A. M., J. B. Kirkpatrick , and E. J. Pharo. 2006. Bryophyte relationships with environmental and structural variables in Tasmanian old-growth mixed eucalypt forest. Australian Journal of Botany **54**:239-247.

Turner, P. A. M., and E. J. Pharo. 2005. Influence of substrate type and forest age on bryophyte species distribution in Tasmania mixed forest. The Bryologist **108**:67-85.

Vernes, K. 2003. Fine-scale habitat preferences and habitat partitioning by three mycophagous mammals in tropical wet sclerophyll forest, north-eastern Australia. Austral Ecology **28**:471-479.

Vernes, K., M. Castellano, and C. N. Johnson. 2001. Effects of season and fire on the diversity of hypogeous fungi consumed by a tropical mycophagous marsupial. Journal of Animal Ecology **70**:945-954.

Villeneuve, N., M. M. Grandter , and J. A. Fortin. 1991a. The study of macrofungal communites: defining adequate sampling units by means of cluster analysis. Vegetatio **94**:125-132.

Villeneuve, N., M. M. Grantner , and J. A. Fortin. 1991b. The coenological organisation of ectomycorrhizal macro fungi in the Laurentide Mountains of Quebec. Canadian Journal of Botany **69**:2215-2225.

Watling, R. 1987. Larger arctic-alpine fungi in Scotland. Pages 17-45 in G.A. Laursen, J.F. Ammirati, and S.A. Redhead, editors. Arctic and Alpine Mycology 2.

Watling, R. 1995. Assessment of fungal diversity: macromycetes, the problems. Canadian Journal of Botany **73**:S15-S24.

Whittaker, R. J., M. B. Araujo, P. Jepson, R. J. Ladle, J. E. M. Watson, and K. J. Willis. 2005. Conservation biogeography: assessment and prospect. Diversity and Distributions **11**:3-23.

Wu, Q., and G. Mueller. 1997. Biogeographic relationships bewtween the macrofungi of temperate eastern Asia and eastern North America. Canadian Journal of Botany **75**:2108-2116.

Zak, J. C., and M. R. Willig. 2004. Fungal biodiversity patterns. Pages 59-75 in Gregory M. Mueller, Gerald F. Bills, and Mercedes S. Foster, editors. Biodiversity of Fungi - Inventory and Monitoring Methods. Elsevier Academic Press, London.

Chapter 4 - Are mosses and macrofungi congruent with vascular plant community and vegetation types?

Abstract

Congruence or distributional similarity, of vascular plant, moss and macrofungal communities across four vegetation types in the Hobart region was compared. This investigation of congruence was carried out to gauge the usefulness of vegetation type and vascular plant community as surrogates for the conservation of mosses and macrofungi composition.

Analyses of similarity (ANOSIM) tests confirmed the four vegetation types were statistically distinct groups of vascular plants, mosses and macrofungi. Non-metric multidimensional scaling (NMDS) ordinations and classification dendograms showed similar site patterns for the vascular plant groups and mosses. Correlations between biotic assemblages (vascular plants, mosses and fungi) and ensembles (grouping of related and functionally similar taxa: woody plants and saprotrophic macrofungi) across the four vegetation types were tested using Partial Mantel tests and the results were statistically significant, with vascular plants and woody plants having the highest r-values with the cryptogams.

The relative strength of the biotic correlations changed when Partial Mantel tests were undertaken on biotic assemblages (vascular plants, mosses and macrofungi) and ensembles (woody plants, saprotrophic macrofungi and ectomycorrhizal macrofungi) limited to wet forest and heathy woodland sites. For these analyses, the correlations between mosses-macrofungi ($r = 0.83$) and mosses-saprotrophic macrofungi ($r = 0.82$) were the strongest. Woody plants and vascular plants still had relatively strong correlations with most cryptogamic groups. But comparisons including ectomycorrhizal macrofungi had lower r-values than most other biotic comparisons, with the strongest r-value being with

the mosses. Congruence between the biotic groups across the four vegetation types in this study, as defined by their vascular plants, suggest that vegetation communities are appropriate surrogates for the mosses and macrofungi for conservation of common taxa in southern Tasmania.

Introduction

Inventory of biodiversity is time-consuming, costly and labour-intensive (Magurran 2004) and, therefore, conservation decisions always are based on incomplete biodiversity data sets. This is why surrogates often are used to try and make informed conservation management decisions. Caro and O'Doherty (1999) described some types of surrogates and suggested a few characteristics needed for them to be effective. A successful surrogate should have a distribution congruent with the target organism. Most importantly, the choice of an appropriate scale seems to be crucial for predictive success (Sullivan & Chesson 1993; Colwell & Coddington 1995; Hammond 1995; Pearson & Carroll 1999; Hunter 2002; Negi & Gadgil 2002; Warman *et al.* 2004; Weber *et al.* 2004).

Some authors have suggested that umbrella or indicator vascular taxa might form effective surrogates for cryptogams (Entwistle 2003; Saetersdal *et al.* 2004), although criticism of this idea - as well as the general idea of surrogacy - has been frequent (Caro & O'Doherty 1999; Saetersdal *et al.* 2005; Favreau *et al.* 2006). There are also some authors who have suggested that abiotic conditions may be better surrogates than vascular plant taxa (Kirkpatrick & Brown 1994; Faith & Walker 1996; Lindenmayer *et al.* 2000; Lindenmayer *et al.* 2002; Faith 2003; Faith *et al.* 2004). Some authors have looked for cross-taxon surrogacy in regard to species richness, but with few outright successes (Crites & Dale 1998; Pharo *et al.* 1999; Ojeda *et al.* 2000; Ingerpuu *et al.* 2001; Negi & Gadgil 2002; Gjerde *et al.* 2004; Chiarucci *et al.* 2005; Gjerde *et al.* 2005; Schmit *et al.* 2005; Dynesius & Zinko 2006; Chiarucci *et al.* 2007).

The use of surrogates has seen some partial successes and some failures. Two cross-taxon studies found evidence for congruence between some of the different taxonomic groups tested (Kati *et al.* 2004; Su *et al.* 2004). Tree diversity was a promising surrogate for macrofungal diversity at the global scale (Schmit *et al.* 2005). However, the distributions of individual tree species were not congruent with those of individual macrofungal species.

Brown *et al.* (1994) summarised the state of non-vascular plant conservation and reservation in Tasmania, but non-lichenised fungi were not considered. They accepted the widespread assumption that, for the most part, the occurrence of non-vascular plant species was strongly related to the distribution of vascular plant species. Although they suggested additional conservation strategies for non-vascular plants, they also asserted that the conservation of cryptogams could be largely achieved by adequate reservation of vascular plant communities.

Pharo and Beattie (2001) found that forest management types were the best surrogate for bryophytes when compared with nine other environmental variables, although there was considerable variation in species composition that was not accounted for when using forest management types. Packham *et al.* (2002) found an overall high level of congruence between vascular plant and macrofungal communities when comparing mature and young regrowth in southern Tasmanian wet forest sites. Pharo *et al.* (1999) found that the best predictors for bryophytes and lichens for species turnover patterns were defined by understorey vascular plants or all vascular plants. Although species composition of vascular plants and cryptogamic groups change across the same environmental gradients, the patterns and rates of these changes often differ (Lee & La Roi 1979; Qian *et al.* 1999). Similarly, Roberts *et al.* (2005) found that considerable variation of bryophytes across sites was not accounted for by the presence of host treefern species. So although treeferns were an important substrate for bryophytes, treefern species alone are unlikely to be a successful surrogate.

Cryptogams are rarely considered by conservation planners (Scott *et al.* 1997; Entwistle 2003; May 2005). Rather, vascular plants and the vegetation types derived from their distributions often are used as untested surrogates for conservation of other groups. There is a need to test the assumption that if the better known vascular plants are conserved, then the cryptogams and other poorly known groups also will be conserved under their 'umbrella'. Testing this assumption is particularly important given the mixed success with using other biotic groups as surrogates for cryptogams, and the paucity of local knowledge about their ecology, particularly the macrofungi.

This chapter therefore seeks to:

1. Determine whether the four vascular plant vegetation types have different moss and macrofungi assemblages;
2. Determine similarities between vegetation types; and
3. Compare the relative strength of correlations between all biotic assemblages and ensembles.

Methods

Four vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath) were surveyed as described in Chapter 2. Presence-absence data sets for all four vegetation types were used for analyses in this chapter, with data compiled from all surveys of the vascular plants, mosses, macrofungi.

Two series of analyses were carried out: (1) included data from all four vegetation types ("four community comparison"); and, (2) included data from only the wet forest and heathy woodland data sets ("two community comparison"). Both assemblages (phylogenetically related taxa in a local area) and ensembles (related taxa in a local area which share a resource or have the same lifeform) of the different taxonomic groups were analysed where possible (definitions of assemblages and ensembles are modified from Fauth *et al.* (1996)). The assemblages analysed were vascular plants, mosses and macrofungi. Ensembles were included in

analyses to check that patterns influenced by lifeform and different resource needs would be considered. The ensembles were woody plants, non-woody plants, saprotrophic macrofungi and ectomycorrhizal macrofungi (see Appendix 3 for lifeform and trophic groupings), although ectomycorrhizal macrofungi could only be analysed in the wet forest and heathy woodland community comparison.

Multivariate analyses

Analysis of similarity, classification (using hierarchical agglomerative clustering), ordinations and Partial Mantel tests for biotic assemblages (vascular plants, mosses and macrofungi) and ensembles (non-woody vascular plants, woody plants, saprotrophic macrofungi and ectomycorrhizal macrofungi) were used as described in Chapter 2.

Results

Separation of vegetation types

The four vegetation types were significantly distinct at $p < 0.0001$ in analyses of similarity (ANOSIM), both globally and for all pair-wise tests, except for heathy and grassy woodland ($p < 0.001$), pair-wise comparisons for each of vascular plants, mosses and macrofungi (Table 1). The high positive values of R, particularly for the vascular plants and mosses, show that there were distinct vegetation types. The heathy-grassy woodland comparison, although statistically significant, was an order of magnitude smaller than the other pair-wise comparisons. This may have been an artefact of having small site numbers because - when ANOSIM's were run with balanced numbers of sites - the probabilities were all of the same order of magnitude.

Table 1. ANOSIM results globally and for pair-wise comparison of four vegetation types for vascular plants, mosses and macrofungi. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

	Vascular plants		Mosses		Macrofungi	
	R	p	R	p	R	p
Global	0.986	<0.0001	0.951	<0.0001	0.900	<0.0001
WF-HE	0.998	<0.0001	0.977	<0.0001	0.971	<0.0001
WF-GR	1	<0.0001	0.996	<0.0001	0.915	<0.0001
WF-MT	1	<0.0001	1	<0.0001	0.931	<0.0001
HE-GR	0.849	<0.001	0.628	<0.001	0.847	<0.001
HE-MT	1	<0.0001	0.911	<0.0001	0.926	<0.0001
GR-MT	1	<0.0001	1	<0.0001	0.879	<0.0001

NMDS ordinations in two dimensions had acceptable stress values (less than 0.20). The NMDS ordination for vascular plants showed four clear groups (Figure 1). The alpine heath and wet forest sites each formed distinct clusters, separate from the grassy woodland and heathy woodland sites, which were non-overlapping in the ordination space, but abutting. The dendogram (Figure 2) reflects the ordination, with the four vegetation types forming distinct clusters at the 50% information remaining level, except that site HED, a heathy woodland site, grouped with the grassy woodland sites rather than the other heathy woodland sites. The grassy woodland (plus HED) cluster and the cluster of the other heathy woodland sites were the last clusters to join at the four-group level. Similar patterns were shown in the ordinations and dendogram of woody plant and non-woody plant data (Figure 3-6).

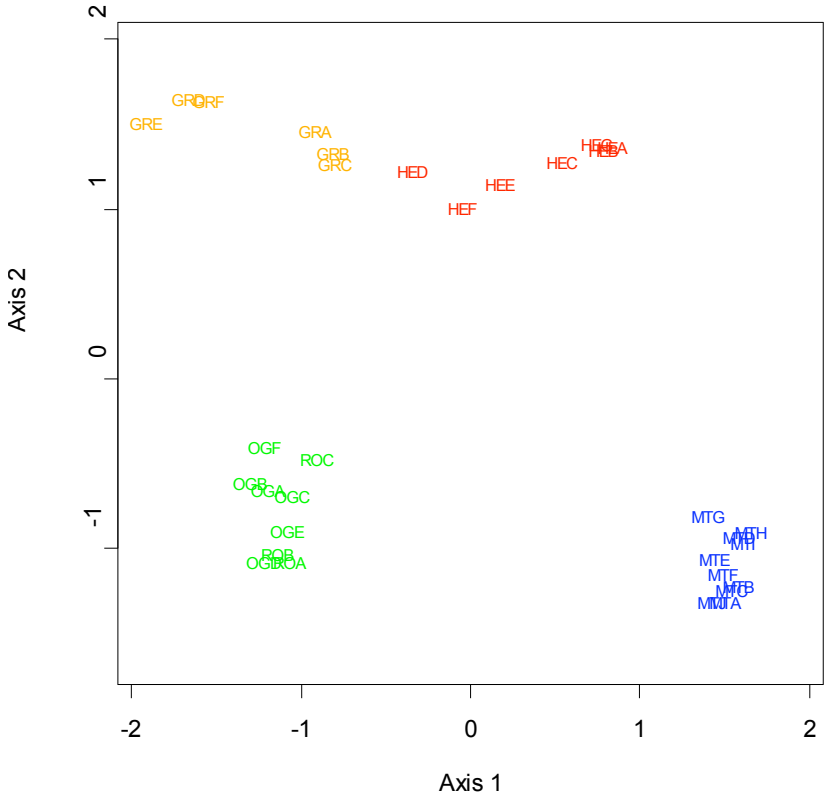


Figure 1. Two dimensional NMDS ordination for vascular plants (ordination stress = 0.10). Site names from Chapter 2, Table 1. Vegetation types : wet forest = green, heathy woodland = red, grassy woodland = orange and alpine heath = blue.

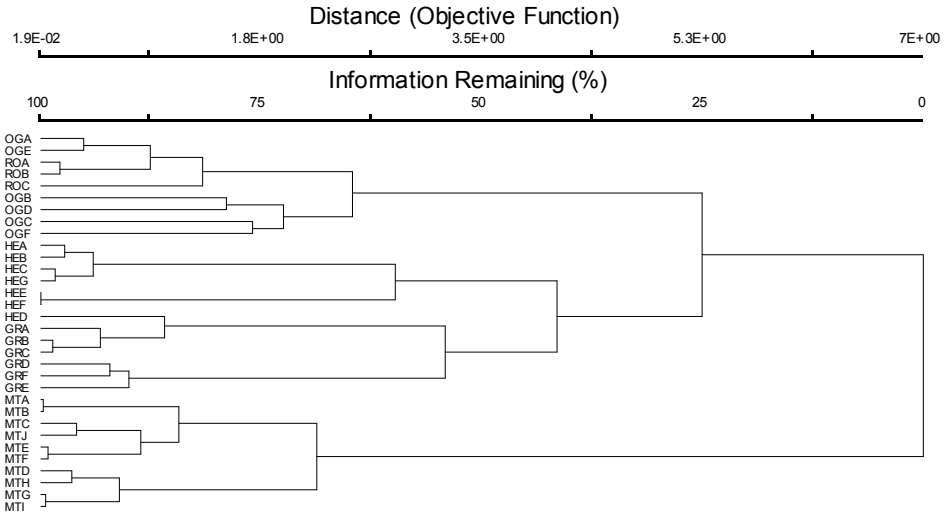


Figure 2. Vascular plant dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

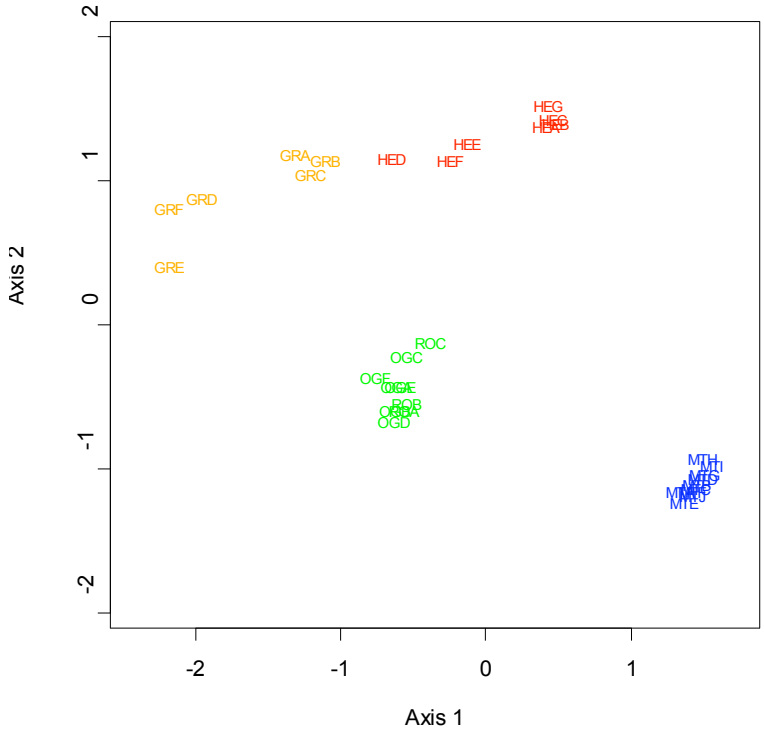


Figure 3. Two dimensional NMDS ordination for woody plants (ordination stress = 0.06). Site names from Chapter 2, Table 1. Vegetation types: wet forest = green, heathy woodland = red, grassy woodland = orange and alpine = blue.

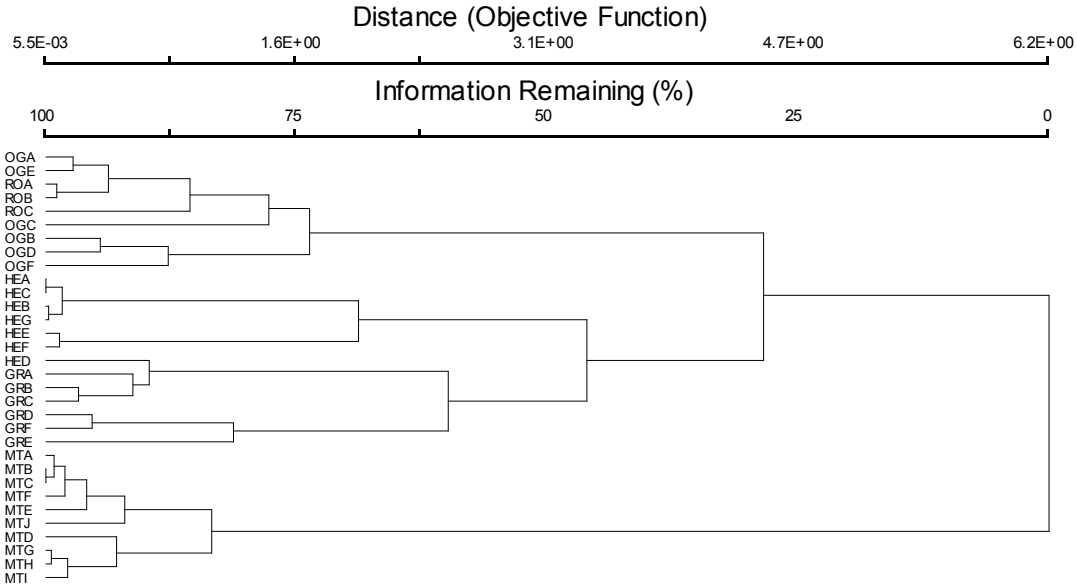


Figure 4. Woody plant dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

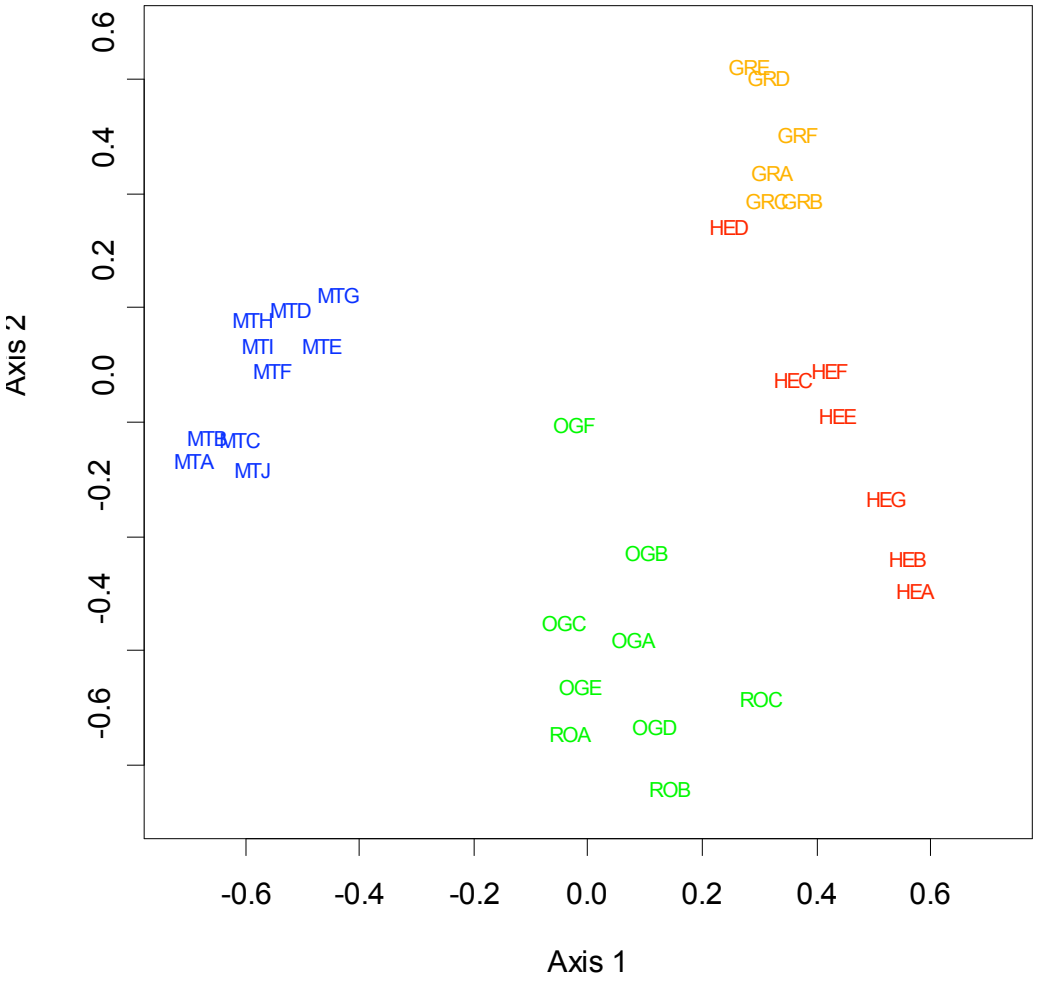


Figure 5. Two dimensional NMDS ordination for non-woody plants (ordination stress = 0.16). Site names from Chapter 2, Table 1. Vegetation types: wet forest = green, heathy woodland = red, grassy woodland = orange and alpine heath = blue.

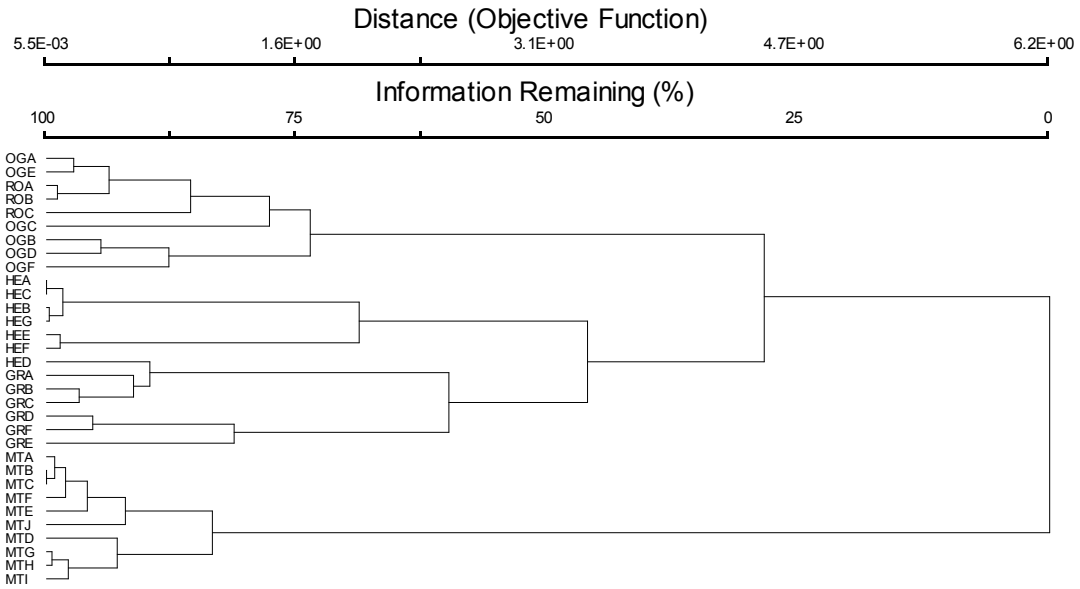


Figure 6. Non-woody plant dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

The ordination of the moss data also showed four groups, as did the dendogram at the 50% information remaining level (Figures 7-8). The wet forest sites were the most different, then the alpine sites separated out. Heathy woodland and grassy woodland sites formed non-overlapping clusters in the ordination, but in the dendogram one heathy woodland site, HED, grouped with the grassy sites.

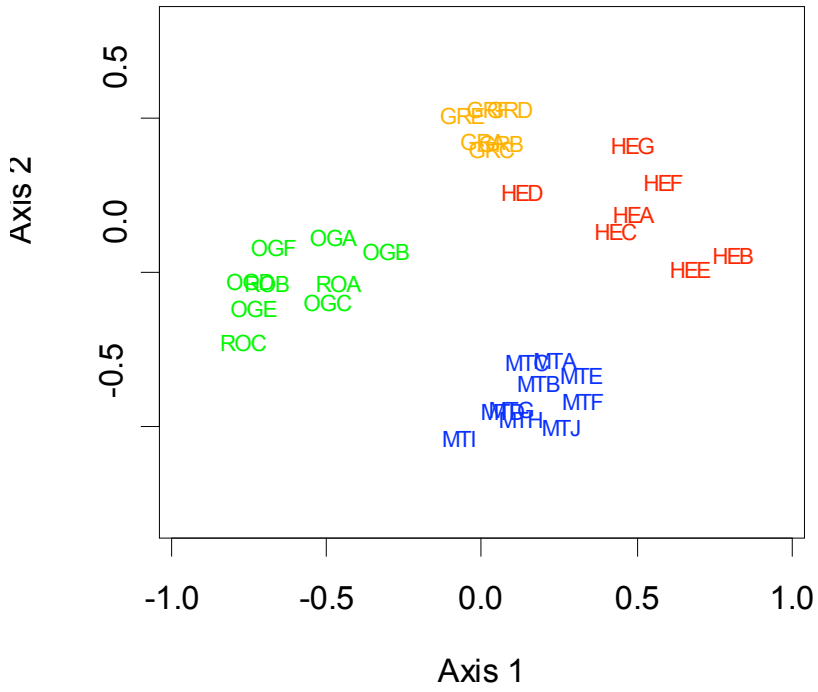


Figure 7. Two dimensional NMDS ordination for mosses (ordination stress = 0.11). Site names from Chapter 2, Table 1. Vegetation types: wet forest = green, heathy woodland = red, grassy woodland = orange and alpine heath= blue.

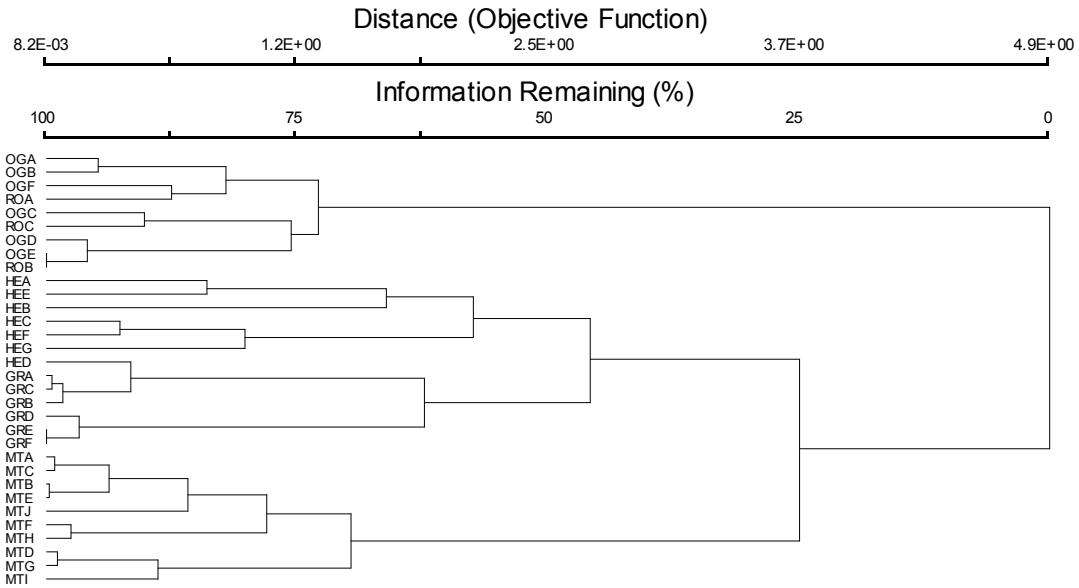


Figure 8. Mosses dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

Ordination of the total macrofungi data, and that for saprotrophic macrofungi both showed three groups (Figure 9-12). These groups had a different pattern to those in ordinations of vascular plant assemblages and ensembles and mosses ordinations. The forest and heathy woodland sites were closest together, with the alpine heath and grassy woodland sites separated out as individual groups. Cluster analysis (Figure 11) supports the interpretation of the ordination as it showed two broad groups, with wet forest and heathy woodland in one group and grassy woodland and alpine heath in another group. (This arrangement might have been an artefact of the low numbers of fungal taxa in the grassy and alpine sites and sharing of common species like *Heterotextus peziziformis*). In the ordination a single alpine site (MTJ) grouped with the wet forest sites; this would have been due to the low number of taxa, including the presence of *Heterotexus peziziformis* and *Marasmius* spp. II, which were most common in the wet forest. Also, within the dendogram of the macrofungi sites, site MTI was grouped with the grassy woodland sites and GRD was grouped with the heathy woodland sites at the 50% 'Information Remaining' level. A similar pattern was found with the saprotrophic macrofungi ordination (Figure 10) but the corresponding dendogram (Figure 12) was more similar to that of the non-woody plants (Figure 6).

In the ordination of the macrofungi data (Figure 9) the grassy woodland and heathy woodland sites reversed their position compared to the ordinations of vascular plant (Figure 1) and moss data (Figure 7). The alpine sites most closely clustered in the vascular plant ordination. The heathy woodland and grassy sites showed similar relative positions for the vascular plant and moss ordinations.

It should be noted that the relative position of individual sites moved between ordinations. The most obvious example, HED, was close to the grassy sites in both the vascular plant and moss ordination, but in the fungi ordination it was close to the forest sites. Many other sites had different relative positions in the different assemblage ordinations, but

were always grouped with other sites from the same broad vegetation type.

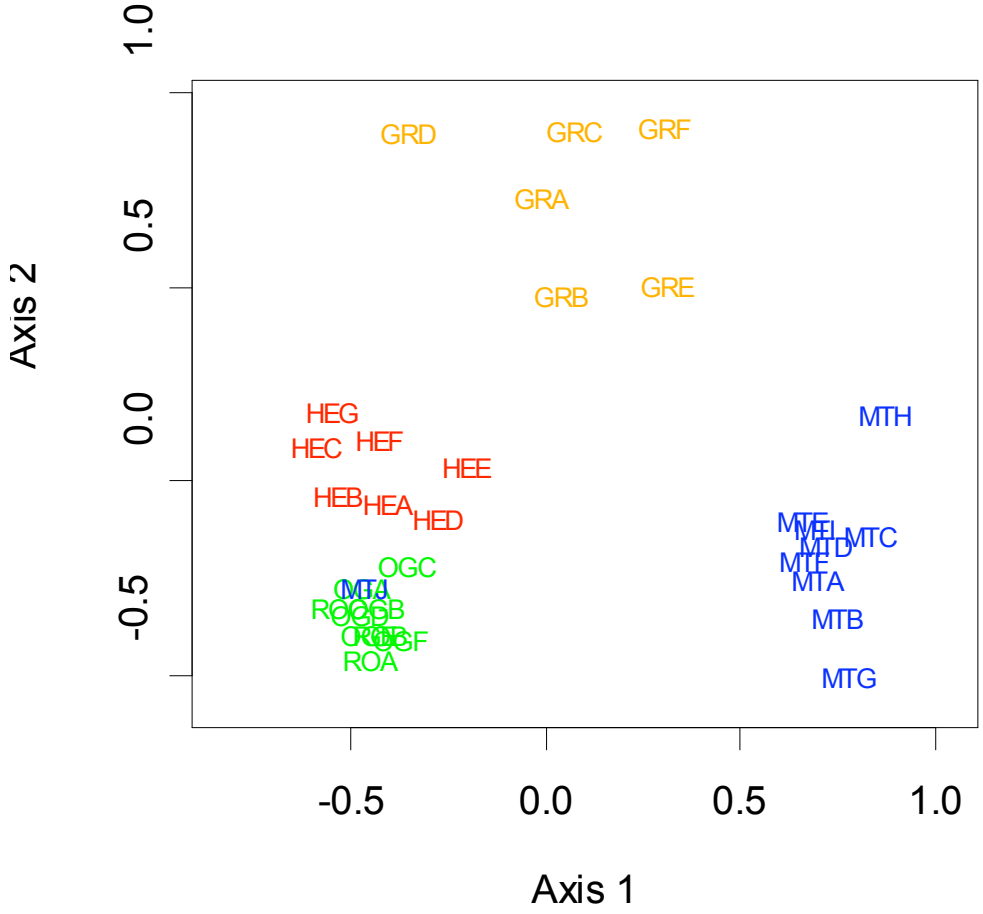


Figure 9. Two dimensional NMDS ordination for macrofungi (ordination stress = 0.14). Site names from Chapter 2, Table 1. Vegetation types: wet forest = green, heathy woodland = red, grassy woodland = orange and alpine heath = blue.

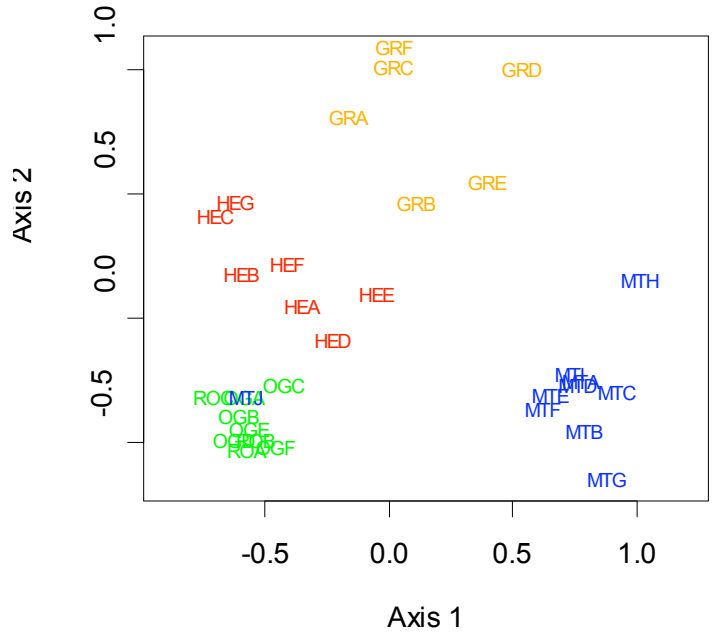


Figure 10. Two dimensional NMDS ordination for saprotrophic macrofungi (ordination stress = 0.18). Site names from Chapter 2, Table 1. Vegetation types: wet forest = green, heathy woodland = red, grassy woodland = orange and alpine heath = blue.

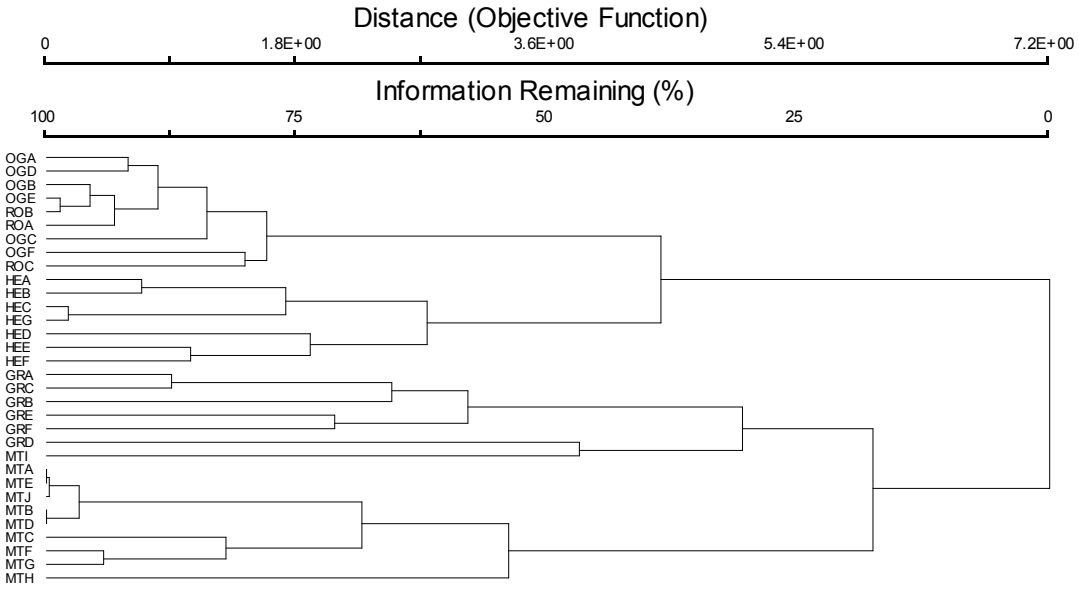


Figure 11. Macrofungi dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

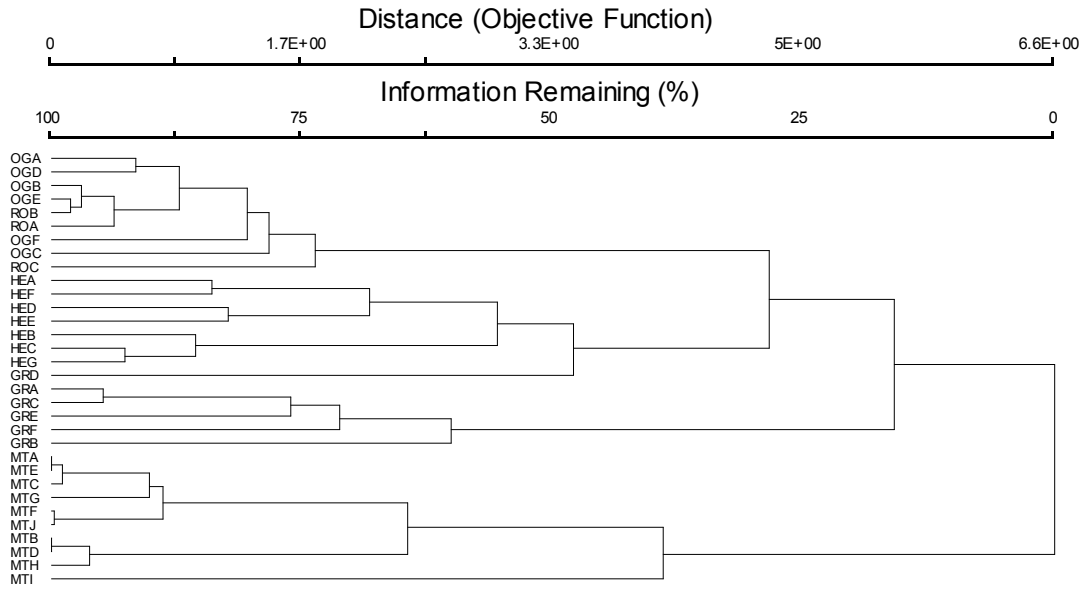


Figure 12. Saprotrophic macrofungi dendogram (hierarchical agglomerative clustering using Bray-Curtis similarity and flexible beta -0.25 for linkage). Vegetation types and sites: wet forest = OGA-F and ROA-C, heathy woodland = HEA-G, grassy woodland = GRA-F and alpine heath = MTA-J.

Biotic comparisons

A series of Partial Mantel test comparisons among assemblages (vascular plants, mosses and macrofungi) and ensembles (woody plants, non-woody plants and saprotrophic macrofungi) were all significant at the 0.001 level (Table 2) and r-values were all higher than 0.5 thus showing strong correlations. The vascular plants-mosses and woody plants-macrofungi associations had the highest r-values of the biotic comparisons at 0.74 (Table 2). Comparisons between both vascular plants and woody plants with the cryptogamic groups had higher r-values than the comparisons against non-woody plants. Of the comparisons involving the non-woody plants, the mosses had the highest r-value. The correlations with the lowest r-values were between non-woody plants and saprotrophic macrofungi and between mosses and macrofungi.

Table 2. Pair-wise Partial Mantel (with geographic stable Matrix) test results for the four community comparison between biotic groups (vascular plants, woody plants, non-woody plants, mosses, fungi and saprotrophic fungi). P-value = < 0.001 for all tests. R-values include confidence interval (CI).

Test factors	r ± 95% CI
Vascular plants - Mosses	0.74 ± 0.08
Woody plants - Macrofungi	0.74 ± 0.08
Woody plants - Saprotrophic macrofungi	0.73 ± 0.07
Woody plants - Mosses	0.72 ± 0.08
Vascular plants - Macrofungi	0.70 ± 0.08
Vascular plants - Saprotrophic macrofungi	0.69 ± 0.07
Non-woody plants - Mosses	0.65 ± 0.07
Non-woody plants - Macrofungi	0.56 ± 0.07
Mosses - Saprotrophic macrofungi	0.56 ± 0.08
Non-woody plants - Saprotrophic macrofungi	0.54 ± 0.07
Mosses - Macrofungi	0.54 ± 0.08

When the Partial Mantel test comparisons were restricted to data from wet forest and heathy woodland sites, there were also significant correlations between assemblages (vascular plants, mosses and macrofungi) and ensembles (woody plants, saprotrophic macrofungi and ectomycorrhizal macrofungi) of the biota (Table 3). The relative strength and also position of many of the test pairs were different from the four community comparison. Most interestingly, the correlations between mosses-macrofungi and mosses-saprotrophic macrofungi had the highest r-values, in contrast to analyses across the four communities. The woody plants and the cryptogamic groups, other than the ectomycorrhizal macrofungi, had the next highest r-values. Followed by vascular plants and the cryptogams, except for the ectomycorrhizal macrofungi, had the next highest correlations. The ectomycorrhizal macrofungi had the lowest r-values, with the mosses-ectomycorrhizal macrofungi correlation being the highest of all the ectomycorrhizal macrofungi relationships. The correlation between the non-woody plants and cryptogamic groups also exhibited a relatively low r-value.

Table 3. Pair-wise Partial Mantel (with geographic stable Matrix) test results for the wet forest and heathy community comparisons between biotic groups (vascular plants, woody plants, non-woody plants, mosses, fungi, saprotrophic fungi and ectomycorrhizal macrofungi). P-value = < 0.001 for all tests. R-values include confidence interval (CI).

Test factors	r ± 95% CI
Mosses - Macrofungi	0.83 ± 0.18
Mosses - Saprotrophic macrofungi	0.82 ± 0.17
Woody plants - Macrofungi	0.77 ± 0.17
Woody plants - Saprotrophic macrofungi	0.76 ± 0.16
Woody plants - Mosses	0.74 ± 0.17
Vascular plants - Macrofungi	0.72 ± 0.17
Vascular plants - Mosses	0.70 ± 0.17
Vascular plants - Saprotrophic macrofungi	0.69 ± 0.17
Non-woody plants - Macrofungi	0.50 ± 0.17
Non-woody plants - Mosses	0.48 ± 0.17
Mosses - Ectomycorrhizal macrofungi	0.48 ± 0.17
Non-woody plants - Saprotrophic macrofungi	0.45 ± 0.17
Vascular plants - Ectomycorrhizal macrofungi	0.38 ± 0.16
Woody plants - Ectomycorrhizal macrofungi	0.38 ± 0.16
Non-woody plants - Ectomycorrhizal macrofungi	0.31 ± 0.18

Discussion

When examined across vegetation types, there was clear congruence between vascular plants and both the mosses and macrofungi. In addition, separate analyses of the moss and macrofungal community produced the same broad pattern of sites reproducing the four vegetation types as defined by the vascular plants. These results were stronger than expected given the weak or absent cross-taxon relationships for most phylogenetic groups (Herben 1987; Negi & Gadgil 2002; Kati *et al.* 2004; Pawar *et al.* 2007). These authors concur that even where cross-taxon relationships are present, distributional details would be needed if this information was to be used for surrogates. Researchers have now found significant cross-taxon relationships, such as those of the present study, when working at landscape or meso-scales (Kati *et al.* 2004; Su *et al.* 2004; Schmit *et al.* 2005).

Given the significant correlations between biotic assemblages and ensembles in the present study, the use of broad vegetation types as

defined by vascular plants is likely to be an appropriate surrogate for the mosses and macrofungi for conservation of common taxa in southern Tasmania. Although some taxa in this study were not common (i.e. taxa only found on a single site), strategies were used to identify some of the more problematic moss and macrofungal taxa by grouping such taxa to higher taxonomic levels. This grouping of some taxa means that many of the uncommon taxa have probably been grouped. However, as the present study was carried out in a limited geographic area, some taxa may only *appear to be* uncommon within this particular range. Therefore issues of global rarity are not suitable for discussion with this data set. However, Molina (2008) shows that there are truly rare macrofungi and there are a number of conservation strategies which may be appropriate for these rare species. Reservation at the scale of vegetation type is a coarse-filter conservation strategy similar to that described by Su *et al.* (2004), who advocate this strategy for common taxa with complementary fine-filter conservation strategies for rarer taxa.

Good surrogates should respond in similar ways, whether this may be due to similar responses due to external influences or due to direct dependence on the organism they predict. The vegetation continuum expressed by the vascular plants, and woody plants in the heathy woodland and grassy woodland sites was likely to be related to variation in available nutrients within similar climates. Although the geology falls into two categories - sandstone and dolerite - local geomorphological variations result in differing nutrient availability (Kirkpatrick pers. com.). For example, intermediate site HED was found on sandstone but also has a substantial component of dolerite colluvium. Site HED also has an intermediate suite of species between grassy and heathy woodland assemblages. The similar response of the mosses to the vascular plants in grassy and heathy sites is likely due to the fact that most mosses in these two vegetation types were found on soil, and thus are exposed to the same substrate variation as the vascular plants. Chiarucci *et al.* (2007) similarly found good predictive patterns between the compositional patterns of vascular plants and bryophytes in a Tuscan forest.

Interestingly, comparison of the patterns in the classification for macrofungi and non-woody plants does not show matching compositional patterns for the heathy and grassy woodland sites. Rather, in these analyses there was greater similarity due to shared macrofungal taxa between the wet forest and heathy woodland sites (Chapter 3). Packham *et al.* (2002) had a site that, based on the macrofungal data, was an intermediate site between the regrowth and mature forest types yet this was not apparent from their vascular plant data. Chiarucci, D'Auria *et al.* (2005) also found that forest macrofungi are more ubiquitous than vascular plants. These contrasting results show that the relationship between surrogates needs to be well understood, and that surrogates need to be used and interpreted with caution. For the cryptogamic indicator species (Saetersdal *et al.* 2005) have proved to be scale dependant. Lee and La Roi (1979) also found compositional congruence between vascular plants and bryophytes along a moisture gradient, but no congruence along an elevation gradient.

The associations between vascular plants and woody plants and the cryptogam groups have similarly strong correlations for the two analyses considered in the present study. For the wet forest and heathy woodland analyses, the moss-macrofungi and moss-saprotrophic macrofungi associations were particularly strong. This result agreed with our understanding of their ecology (McCune & Antos 1981; Hansen & Tyler 1992; Qian *et al.* 1999; Sadler & Bradfield 2000; Macdonald *et al.* 2001; Mills & Macdonald 2004, 2005; Schmit *et al.* 2005). Many mosses and fungi have close associations with specific substrates (Scholfield 1985; Andersson & Hytteborn 1991; Tyler 1992; Scott 1994; Scott *et al.* 1997; Rambo & Muir 1998; Bates 2000; Berglund & Jonsson 2001; Humphrey *et al.* 2002; Penttila *et al.* 2004; Dynesius & Zinko 2006; Lohmus *et al.* 2007). Substrate relationships will be further investigated in later chapters.

Differences in the relative strength of the correlation between the different macrofungal ensembles (saprotrophic and ectomycorrhizal)

compared to macrofungi as a whole, show that different trophic groups may have different responses. For example, the ectomycorrhizal ensemble had significant, yet low correlations with the vascular plant groups, with the highest correlation between ectomycorrhizal macrofungi and the mosses. This may be due in part to a smaller data set for the ectomycorrhizal fungi. In addition, ectomycorrhizal communities are recognised as particularly complex, making data interpretation problematic when it is limited to fruit-body observations (Nantel & Neumann 1992; Francis & Read 1995; van der Heijden *et al.* 1999; Ferrer & Gilbert 2003).

The present study shows four vegetation types, as defined by vascular plants, also have distinctive moss and macrofungal assemblages. The Partial Mantel tests confirm congruence between vascular plants, mosses and macrofungi within vegetation types. There are significant correlations between all biotic groups; the rank of these relationships depends on data set analysed. The four vegetation types in this study, as defined by their vascular plants, are appropriate surrogates for the mosses and macrofungi for the purposes of conservation of common taxa in southern Tasmania.

References

Andersson, L. I., and H. Hytteborn. 1991. Bryophytes and decaying wood - a comparison between managed and natural forest. Holarctic Ecology **14**:121-130.

Bates, J. W. 2000. Mineral nutrition, substratum ecology, and pollution. Pages 248-311 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Berglund, H., and B. G. Jonsson. 2001. Predictability of plant and fungal species richness of old-growth boreal forest islands. Journal of Vegetation Science **12**:857-866.

Brown, M. J., S. J. Jarman , and G. Kantvilas. 1994. Conservation and reservation of nonvascular plants in Tasmania, with special reference to lichens. Biodiversity and Conservation **3**:263-278.

Caro, T. M., and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology **13**:805-814.

Chiarucci, A., F. D'Auria, V. De Dominicis, A. Lagana, C. Perini, and E. Salerni. 2005. Using vascular plants as a surrogate taxon to maximise fungal species richness in reserve design. Conservation Biology **19**:1644-1652.

Chiarucci, A., F. D'Auria, and I. Bonini. 2007. Is vascular plant species diversity a predictor of bryophyte species diversity in Mediterranean forests? Biodiversity and Conservation **16**:525-545.

Colwell, R. K., and J. A. Coddington. 1995. Estimating terrestrial biodiversity through extrapolation in D. L. Hawksworth, editor. Biodiversity: Measurement and Estimation. Chapman & Hall, London.

Crites, S., and M. R. T. Dale. 1998. Diversity and abundance of bryophytes, lichens, and fungi in relation to woody substrate and successional stage in aspen mixed-wood boreal forests. Canadian Journal of Botany **76**:641-651.

Dynesius, M., and U. Zinko. 2006. Species richness correlations among primary producers in boreal forests. Diversity and Distributions **12**:703-713.

Entwistle, T. 2003. An introduction to the conservation of cryptogams. Pages 1-3 in C. L. Brown, F. Hall, and J. Mill, editors. Plant Conservation - Approaches and Techniques from an Australian Perspective. Australian Network for Plant Conservation, Australia.

Faith, D. P. 2003. Environmental diversity (ED) as surrogate information for species level biodiversity. Ecography **26**:374-379.

Faith, D. P., S. Ferrier, and P. A. Walker. 2004. The ED strategy: how species level surrogates indicate general biodiversity patterns through an 'environmental diversity' perspective. Journal of Biogeography **31**:1207-1217.

Faith, D. P., and P. A. Walker. 1996. Environmental diversity: on the best possible use of surrogate data for assessing the relative biodiversity of sets of areas. Biodiversity and Conservation **5**:399-415.

Fauth, J. E., J. Bernado, M. Camara, W. J. Resetarits, J. Van Buskirk, and S. A. McCollim. 1996. Simplifying the jargon of community ecology: a conceptual approach. American Naturalist **147**:282-286.

Favreau, J. M., C. A. Drew, G. R. Hess, M. J. Rubino, F. H. Koch, and K. A. Eschelbach. 2006. Recommendations for assessing the effectiveness of surrogate species approaches. Biodiversity and Conservation **15**:3949-3969.

Ferrer, A., and G. S. Gilbert. 2003. Effect of tree host species on fungal community composition in a tropical rain forest in Panama. Diversity and Distributions **9**:455-468.

Francis, R., and D. J. Read. 1995. Mutualism and antagonism in the mycorrhizal symbiosis with special reference to impacts on plant

community structure. Canadian Journal of Botany **73**:S1301-S1309.

Gjerde, I., M. Saeterdal, J. Rolstad, K. O. Storaunet, H. H. Blom, V. Gundersen, and E. Heegaard. 2005. Productivity-diversity relationships for plants, bryophytes, lichens, and polypore fungi in six northern forest landscapes. Ecography **28**:1-16.

Gjerde, I., M. Saetersdal, J. Rolstad, H. H. Blom, and K. O. Storaunket. 2004. Fine-scale diversity and rarity hotspots in northern forests. Conservation Biology **18**:1032-1042.

Hammond, P. M. 1995. Practical approaches to the estimation of the extent of biodiversity in speciose groups. Pages 119-136 in D. L. Hawksworth, editor. Biodiversity: Measurement and Estimation. Chapman & Hall, London.

Hansen, P. A., and G. Tyler. 1992. Statistical evaluation of tree species affinity and soil preference of the macrofungal flora in south Swedish beech, oak and hornbeam forests. Cryptogam Botany **2**:355-361.

Herben, T. 1987. Bryophytes in grassland vegetation sample plots: What is their correlation with vascular plants? Folia Geobotanica et Phytotaxonomica **22**:35–41.

Humphrey, J. W., S. Davey, A. J. Peace, R. Ferris, and K. Harding. 2002. Lichens and bryophyte communities of planted and semi-natural forests in Britain: the influence of site type, stand structure and deadwood. Biological Conservation **107**:165-180.

Hunter, M. L. J. 2002. Fundamentals of Conservation Biology. Blackwell Science, Cambridge, Massachusetts.

Ingerpuu, N., K. Vellack, T. Kukk, and M. Partel. 2001. Bryophyte and vascular plants species richness in boreo-nemoral moist forests and mires. Biodiversity and Conservation **10**:2153-2166.

Kati, V., P. Devillers, M. Difreme, A. Legakis, D. Vikou, and P. Lebrun. 2004. Testing the value of six taxonomic groups as biodiversity indicators at local scale. Conservation Biology **18**:667-675.

Kirkpatrick , J. B., and M. J. Brown. 1994. A comparison of direct and environmental domain approaches to planning reservation of forest higher plant communities and species in Tasmania. Conservation Biology **8**:217-224.

Lee, T. D., and G. H. La Roi. 1979. Bryophyte and understory vascular plant beta diversity in relation to moisture and elevation gradients. Vegetatio **40**:29-38.

Lindenmayer, D. B., R. B. Cunningham, C. F. Donnelly, and R. Lesslie. 2002. On the use of landscape surrogates as ecological indicators in fragmented forests. Forest Ecology and Management **159**:203-216.

Lindenmayer, D. B., C. R. Margules, and D. B. Botkin. 2000. Indicators of biodiversity for ecologically sustainable forest management. Conservation Biology **14**:941-950.

Lohmus, A., P. Lohmus, and K. Vellak. 2007. Substratum diversity explains landscape-scale co-variation in the species-richness of bryophytes and lichens. Biological Conservation **135**:404-414.

Macdonald, S. E., L. Cuthbertson, B. Frey, T. Fenniak, L. Lazaruk, S. Kembell, S. Mills, V. Lieffers, M. B. Dale, K. Mallett, A. Munson, and D. H. Vitt. 2001. Pattern and process in Boreal Forest understory. Patterns and process of the boreal forest understory: a comparison of post-fire and post-harvest dynamics. Sustainable Forest Managment Network Project.

Magurran, A. E. 2004. Measuring Biological Diversity. Blackwell Publishing, Carlton.

May, T. W. 2005. Forgotten flora remembered. Australasian Plant Conservation **14**:2-3.

McCune, B., and A. Antos. 1981. Correlations between forest layers in the Swan Valley, Montana. Ecology **62**:1196-1204.

Mills, S. E., and S. E. Macdonald. 2004. Predictors of moss and liverwort species diversity of microsites in conifer-dominated boreal forest. Journal of Vegetation Science **15**:189-198.

Mills, S. E., and S. E. Macdonald. 2005. Factors influencing bryophyte assemblage at different scales in the western Canadian boreal forest. Bryologist **108**:86-100.

Molina, R. 2008. Protecting rare, little known, old-growth forest-associated fungi in the Pacific Northwest USA: A case study in fungal conservation. Mycological Research **112**:613-638.

Nantel, P., and P. Neumann. 1992. Ecology of ectomycorrhizal-basidiomycete communities on a local vegetation gradient. Ecology **73**:99-117.

Negi, H. R., and M. Gadgil. 2002. Cross-taxon surrogacy of diversity in the Indian Garhwal Himalaya. Biological Conservation **105**:143-155.

Ojeda, F., T. Marañón, and J. Arroyo. 2000. Plant diversity patterns in the Aljibe Mountains (S. Spain): a comprehensive account. Biodiversity and Conservation **9**:1323-1343.

Packham, J. M., T. W. May, M. J. Brown, T. J. Wardlaw, and A. K. Mills. 2002. Macrofungal diversity and community ecology in mature and regrowth wet eucalypt forest in Tasmania: A multivariate study. Austral Ecology **27**:149-161.

Pawar, S. S., A. C. Biand, M. F. Ahmed, S. Sengupta, and T. R. Shankar Raman. 2007. Conservation biogeography in North-east India: hierarchical analysis of cross-taxon distributional congruence. Diversity and Distributions **13**:53-65.

Pearson, D. L., and S. S. Carroll. 1999. The influence of spatial scale on cross taxon congruence patterns and prediction of accuracy of species richness. Journal of Biogeography **26**:1079-1090.

Penttila, R., J. Siitonen, and M. Kuusinen. 2004. Polypore diversity in managed and old-growth boreal *Picea abies* forests in southern Finland. Biological Conservation **117**:271-283.

Pharo, E. J., and A. J. Beattie. 2001. Management forest types as a surrogate for vascular plant, bryophyte and lichen diversity. Australian Journal of Botany **49**:23-30.

Pharo, E. J., A. J. Beattie, and D. Binns. 1999. Vascular plant diversity as a surrogate for bryophyte and lichen diversity. Conservation Biology **13**:282-292.

Qian, H., K. Klinka, and X. H. Song. 1999. Cryptogams on decaying wood in old-growth forests of southern coastal British Columbia. Journal of Vegetation Science **10**:883-894.

Rambo, T. R., and P. S. Muir. 1998. Bryophyte species associations with coarse woody debris and stand ages in Oregon. The Bryologist **101**:366-376.

Roberts, N. R., P. J. Dalton, and G. J. Jordon. 2005. Epiphytic ferns and bryophytes of Tasmanian tree ferns: a comparison of diversity and composition between two host species. Austral Ecology **30**:146-154.

Sadler, K. D., and G. E. Bradfield. 2000. Microscale distribution patterns of terrestrial bryophytes in a subalpine forest: the use of logistic regression as an interpretive tool. Community Ecology **1**:57-64.

Saetersdal, M., I. Gjerde, and H. H. Blom. 2005. Indicator species and the problem of spatial inconsistency in nestedness patterns. Biological Conservation **122**:305-316.

Saetersdal, M., I. Gjerde, H. H. Blom, P. G. Ihlen, E. W. Myrseth, R. Pommeresche, J. Skartveit, T. Solhoy, and O. Aas. 2004. Vascular plants as a surrogate species group in complimentary site selection for bryophytes, macrolichens, spiders, carabids, staphlinids, snails, and wood living polypore fungi in a northern forest. Biological Conservation **115**:21-31.

Schmit, J. P., G. Mueller, P. R. Leacock, J. L. Mata, Q. Wu, and Y. Huang. 2005. Assessment of tree species richness as a surrogate for macrofungal species richness. Biological Conservation **121**:99-110.

Scholfield, W. B. 1985. Introduction to Bryology. Macmillan Publishing Company, New York.

Scott, G., T. Entwistle, T. May, and N. Stevens, editors. 1997. A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi. Environment Australia, Canberra.

Scott, G. A. M. 1994. Elementary reflections on the biology of bryophytes. The Victorian Naturalist **111**:112-115.

Su, W., D. M. Debinski, M. E. Jakubauskas, and K. Kindscher. 2004. Beyond species richness: community similarity as a measure of cross-taxon and congruence for coarse-filter conservation. Conservation Biology **18**:167-173.

Sullivan, M., and J. Chesson. 1993. The use of Surrogate Measurements for Determining Patterns of Species Distribution and Abundance. Resource Assessment Commission, Research Paper No. **8**:1-38.

Tyler, G. 1992. Tree species affinity of decomposer and ectomycorrhizal macrofungi in beech (*Fagus sylvatica* L.), oak (*Quercus roburt* L.) and hornbeam (*Carpinus betulus* L.) forests. Forest Ecology and Management **47**:269-284.

van der Heijden, E. W., F. W. de Vries, and T. Kuyper, W. 1999. Mycorrhizal associations of *Salix repens* L. communities in succession of dune ecosystems. I. Above-ground and below-ground views of ectomycorrhizal fungi in relation to soil chemistry. Canadian Journal of Botany **77**:1821-1832.

Warman, L. D., A. R. E. Sinclair, G. G. E. Scudder, B. Klinkenberg, and R. L. Pressey. 2004. Sensitivity of systematic reserve selection to decisions about scale, biological data, and targets: case study from southern British Columbia. Conservation Biology **18**:655-666.

Weber, D., U. Hintermann, and A. Zangger. 2004. Scale and trends in species richness: considerations for monitoring biological diversity for political purposes. Global Ecology and Biogeography **13**:97-104.

Chapter 5 - Relationships of vascular plant, moss and macrofungal groups with environmental and substrate factors

Abstract

Environmental and substrate information may be a useful surrogate in the management of cryptogams as such information is easier to gather than full cryptogamic surveys. To test this, Partial Mantel tests were carried out between environmental and substrate factors and biotic assemblages (vascular plants, mosses, and macrofungi) and ensembles (grouping of related and functionally similar taxa: woody plants, non-woody plants, and saprotrophic macrofungi). These biotic groups, as well as ectomycorrhizal fungi, were also tested for the wet forest and heathy woodland sites. Significant associations were found between environmental and substrate factors with all the biotic groups tested, correlations which have rarely been shown for Australian mosses and macrofungi. Most correlations between the biotic assemblages and ensembles with environmental factors were significant. In fact, correlations including the vascular plants and woody plants consistently had the highest r-values.

Canopy cover is the best single predictor for most of the biotic groups for both series of analyses. Site environmental factors in combination had the higher correlations with the biotic groups than single factors, substrate factors or combinations of substrate and environmental factors. The combination of canopy cover, geology, altitude, rainfall, mean daily maximum temperature for July, daily radiation for December and slope produced the highest r-values for most of the biotic groups for the four community comparisons, while the combination of altitude, canopy cover and geology had the highest r-values for the wet forest and heathy woodland comparison. Some substrate variables and combinations of substrate variables also had significant correlations with the biotic

groups. Small wood and large wood had the highest correlations for all biotic groups for single factor analysis for both series of analyses. The combination of substrates that gave the highest correlation values were small and large wood, rock and humus. This combination showed the best r-values for substrate for four community analyses. Moss and macrofungal taxa were found on all substrates within wet forest. In the other vegetation types mosses were predominantly found on soil while macrofungi were most common on soil and woody substrates.

Introduction

The relationship between environmental variables and vascular plants has long been recognised by ecologists and biogeographers (van Hulst 1978; McCune & Antos 1981a; van der Maarel 1988; Diekmann & Falkengren-Grerup 1998). The distribution of plants has long been recognised as being influenced by physical factors such as light, moisture, and nutrients (Begon *et al.* 1990; Cox & Moore 1993). More recently mycorrhizal fungi have been recognised as an influencing factor (Allen & Allen 1984; Brundrett 1991; Dahlberg 2001; van der Heijden & Sanders 2002; Kennedy *et al.* 2003). Fungi generally are also important in ecosystem nutrient cycles (Dighton 1995; Colpaert & Van Tchelen 1996; Tommerup & Bougher 2000; Boddy 2001). Bryophytes help regulate moisture (Söderström 1988b; McAlister 1995; Mills & Macdonald 2005; Dynesius & Zinko 2006; Jansova & Soldan 2006; Standovar *et al.* 2006) and terrestrial cryptogams facilitate water infiltration (Eldridge *et al.* 2000). Despite important roles in ecosystems little is generally known about cryptogam ecology in Australia (Bougher & Tommerup 1996; May & Simpson 1997; Scott *et al.* 1997; Tommerup *et al.* 2000). Elucidation of the relationships between cryptogamic groups and environmental factors will improve our understanding of the ecology of these groups and may identify factors that could help predict cryptogam distributions in a management context (Vanderpoorten & Engels 2002).

If there is to be predictive value in relationships between environmental and different biotic groups, not only do the different biotic groups need to

respond to the same environment factors but they also need to respond to changes in a similar way. This point is highlighted by the work on Montanan forest vegetation layers by (McCune & Antos 1981a). They found that, although there were weak, yet significant, correlations between the different vegetation layers, including bryoid and epiphytic layers, the rate of change across environmental gradients was not consistent between the layers.

Cryptogams respond to climatic (e.g. precipitation, light, temperature), ecologic (e.g. pH, land use, vegetation types, vegetation cover) and geographic (e.g. geology, soil types, pH, land use, vegetation cover) environmental factors (Petersen 1985; Hansen & Tyler 1992; Nantel & Neumann 1992; Dix & Webster 1995; Qian *et al.* 1999; Bates 2000; Claridge *et al.* 2000a; Claridge *et al.* 2000b; Franks & Bergstrom 2000; Ojeda *et al.* 2000; van der Heijden & Sanders 2002; Vanderpoorten & Engels 2002; Mulder & de Zwart 2003; Heilmann-Clausen *et al.* 2005; Dynesius & Zinko 2006). Amongst these many relationships some authors have found a strong link between species richness of cryptogams and diversity of substrate (McCune & Antos 1981b; Söderström 1981; Watson 1981; Mills & Macdonald 2004; Bruun *et al.* 2006; Lobel *et al.* 2006).

In Australia, research on bryophytes supports the supposition that if, at a smaller scale (tens of metres to tens of kilometres), the required combinations of environmental and substrate factors are present, and assuming that issues of dispersal are not a factor, cryptogams will inhabit particular microsites (Fensham & Streimann 1997; Franks & Bergstrom 2000; Pharo & Blanks 2000; Pharo & Beattie 2002; Kellar *et al.* 2006; Turner *et al.* 2006). For hypogeous macrofungi (Claridge *et al.* 2000a) have shown that the distribution of individual species are affected by meso- and micro-scale site attributes. The substrates that cryptogams selectively inhabit vary from the abiotic, such as soil and rocks (Dix & Webster 1995; Dynesius & Zinko 2006; Virtanen & Oksanen 2007), to the biotic, such as woody debris (Dix & Webster 1995; Macdonald *et al.* 2001; Arsenault 2002; Standovar *et al.* 2006).

Woody debris is an important factor in cryptogam ecology. The quantity, type and decay stage of woody debris is related to the size and age of woody plants and the site disturbance history (Rayner & Boddy 1988; Kirby *et al.* 1991; Franklin 1998; MacKinnon & Trofymow 1998; Jonsson 2000; Fraver *et al.* 2002; Kruys *et al.* 2002). Strong links have been found between woody debris and cryptogams (Söderström 1988a; Andersson & Hytteborn 1991; Crites & Dale 1995; Dix & Webster 1995; Crites & Dale 1998; Mills *et al.* 2001; Arsenault 2002; Norden *et al.* 2004; Odor *et al.* 2005). Many fungi, particularly basidiomycetes, are specialised wood decay organisms, and woody substrates can support rich communities of fungi (Dix & Webster 1995; Kruys & Jonsson 1999). Predictable successions of bryophyte and fungi species on woody debris have been shown (Scholfield 1985; Dix & Webster 1995; Kendrick 2000; Mills *et al.* 2001).

The structure of trees and stands of trees influences the distribution of cryptogams (Scholfield 1985; Berglund & Jonsson 2001; Heylen *et al.* 2005; Kellar *et al.* 2006; Standovar *et al.* 2006). Site microclimates are also influenced by structure (van Hulst 1978). In western Canadian boreal forest, Mills and Macdonald (2005) found that bryophyte composition was significantly related to available moisture at the three scales they considered (micro, meso and stand) while other significant factors were scale dependent. Sadler and Bradfield (2000) highlighted the influences of other bryophyte species, substrate and microclimate on terrestrial bryophyte composition at the microscale (0.1 m^2).

Environmental and substrate information may be a useful surrogate in the management of cryptogams as such information is easier to gather than full cryptogamic surveys. For such information to be of use, it must elucidate which factors, if any, predict cryptogam distributions. This chapter investigates the correlations and the relative strength of relationships between biotic groups with:

1) single substrate and environmental factors;
2) combinations of substrate and environmental factors.

Methods

Biotic and environmental data sets (including substrate cover) for each site were compiled from the surveys described in Chapter 2. Presence/absence data was used for the biotic assemblages (vascular plants, mosses, and macrofungi) and ensembles (woody plants, non-woody plants, saprotrophic macrofungi and ectomycorrhizal macrofungi) (Chapter 2). Both assemblages (phylogenetically related taxa in a local area) and ensembles (related taxa in a local area which share a resource or have the same lifeform) of the different taxonomic groups were analysed where possible. (Definitions of assemblages and ensembles are modified from Fauth *et al.* (1996))). The environmental factors consisted of location (easting, northing, elevation), geology, mean canopy cover, mean annual rainfall, mean minimum and maximum temperatures for February (hottest month) and July (coldest month), mean annual solar radiation, mean daily solar radiation for December (highest solar radiation month) and June (lowest solar radiation month), slope and aspect. Environmental factors were standardised for analysis so each factor ranged from zero to one for continuous variables. Qualitative factors, such as the geology of sites, were recorded in classes as zero or one for each geology type. Factors were not weighted.

Values for the substrate variables for each site were calculated by averaging the midpoints of the cover-abundance class values recorded from the 10 strip-plots within the site. Substrates were soil, rock, humus (cover of humus or organic soil in alpine sites), cryptogams (cover of algae, bryophytes and lichens), litter (leaves and wood smaller than 1 cm in diameter), small wood (wood 1-5 cm diameter) and large wood (wood ≥ 5 cm diameter, including stumps) and burnt wood (that is, wood exhibiting obvious charring or charcoal).

A general linear model was run to test the relationship between vegetation type and substrate (Mintab Inc 2000), this is equivalent to an ANOVA (Analysis of variance) and allows for the unbalanced number of sites in each vegetation type. This analysis was carried out by comparing

the four vegetation types with the mean substrate cover for soil, rock, humus, cryptogams, litter, small wood, and large wood. Burnt soil and wood were not included in the analysis as these were absent from most sites.

Partial Mantel tests were carried out to test correlations between distance matrices using methods described in Chapter 2. Tests were carried out on single factors and combinations of factors. Two series of Partial Mantel tests were carried out: the first was on all four vegetation types and included all biotic groups except for ectomycorrhizal macrofungi which were not present on all sites. This will be referred to as the 'four community comparison'. The second series of Partial Mantel tests were run on a data set including only wet forest and heathy woodland sites. This series included all biotic groups. These two communities had overlapping environmental variables and had the same survey effort. This series of Partial Mantel tests based on wet forest and heathy woodland will be referred to as the 'two community comparison'.

Results

Environmental factors between communities

The alpine heath sites on the plateau of Mount Wellington had the most distinctive environment, with the least canopy cover, highest rainfall and solar radiation and lowest temperatures (Table 1). The wet forest, heathy and grassy woodland sites were more similar to each other, with most factors having overlapping ranges. Canopy cover was the most distinctive variable (Figure 1 and Figure 2: A-D)., with alpine heath sites having the lowest mean cover. The wet forest sites had the highest canopy cover of all four vegetation types.

Table 1. Ranges of Environmental factors across vegetation types.

Factors	Wet Forest	Heathy woodland	Grassy woodland	Alpine heath*
Altitude (m)	170-360	70-240	100-220	1240
Canopy cover (%)	65-80	0-50	4-14	0-2
Mean annual rainfall (mm)	625-800	725-750	650-750	1400
Mean daily maximum temperature Feb (°C)	20.1-21.3	20.9-21.8	21-21.8	13.5
Mean daily minimum temperature Feb (°C)	9.6-10.8	10.4-10.6	10.5-11.3	5.3
Mean daily maximum temperature July (°C)	8.4-9.6	9.2-12.4	9.3-10.1	2.2
Mean daily minimum temperature July (°C)	1-2.2	1.8-2.3	1.9-2.7	-1.7
Slope (°)	6-26	3.5-22	9-15	0-4
Mean daily solar radiation June ($MJm^{-2}day^{-1}$)	3.2-6.5	3.5-7.2	3.5-4.2	5.2
Mean daily solar radiation Dec ($MJm^{-2}day^{-1}$)	20.7-21.7	21.2-21.7	21-21.5	22
Total mean annual solar radiation (MJm^{-2})	4500-5200	4500-5200	4200-4500	4750

* Alpine heath sites were all located in the same area so only the canopy cover varies.

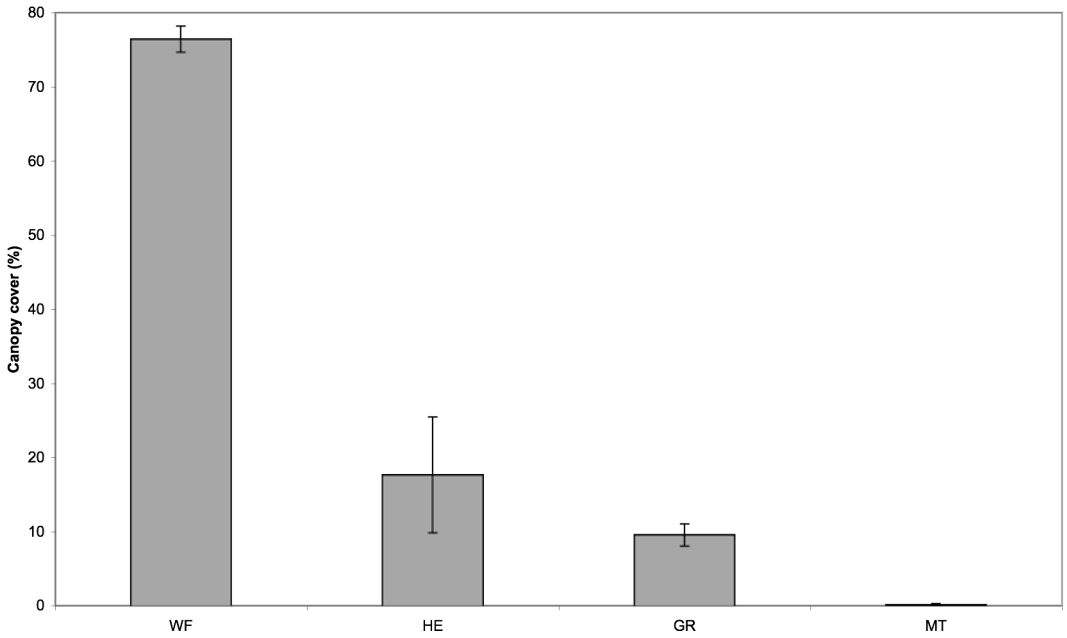


Figure 1. Mean canopy cover of trees and shrubs (including standard error) for each vegetation type (WF = wet forest, HE = heathy woodland, GR – grassy woodland and MT = alpine heath.

Differences in substrate between communities

There were clear differences in the mean substrate cover between the four vegetation types (Figure 3). A generalised linear model found a significant relationship between mean substrate cover and vegetation types (F-value = 3.8, Degrees of freedom = 21, p-value = < 0.0001).

The amount of shade varied greatly between the four vegetation types. The suitability of different substrates, particularly logs, for cryptogams related to the amount of canopy cover of the vegetation type (Figure 2). Alpine heath had no tree canopy, thus no larger logs, and the smaller wood was dry and exposed (Figure 2: D and H). Heathy and grassy woodland had open canopies. Wood in these conditions was usually dry (Figure 2: B, C, F, G and H). Wet forest had a closed canopy, producing a shaded and moist understorey at most sites, providing conditions conducive to bryophyte mats, which were common on logs and tree buttresses (Figure 2: A and E).

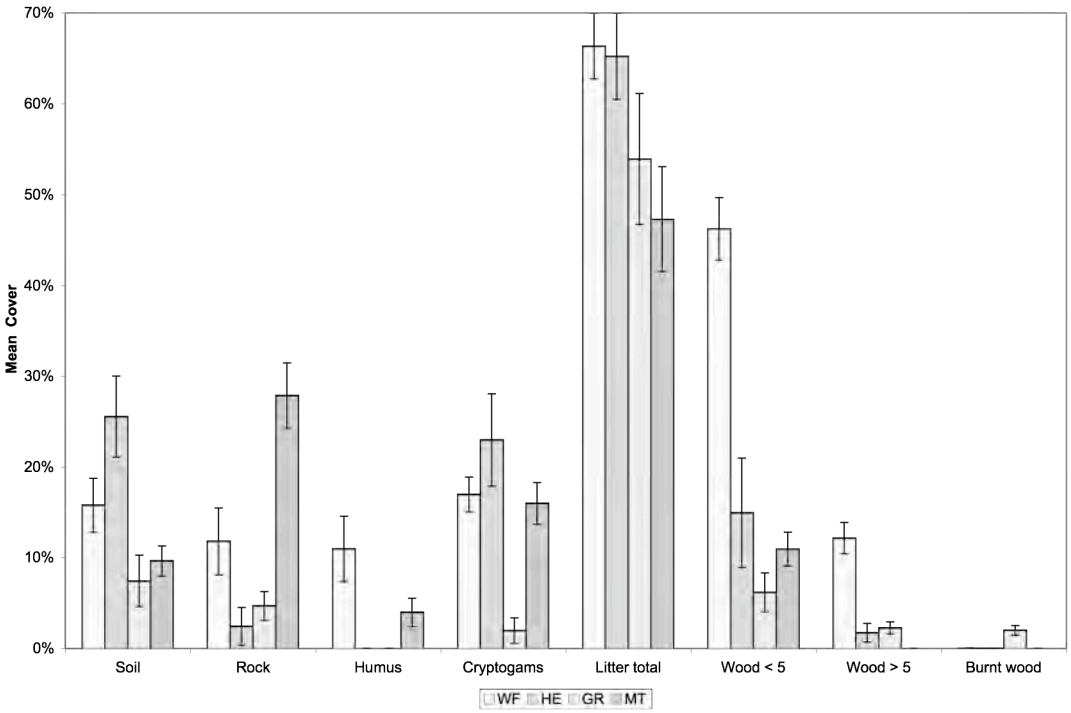


Figure 3. Mean cover (including standard error) for each substrate for each of the vegetation types. WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath.

Although a substrate class may be present in all four communities, the character of these substrate classes varied between the four vegetation types. An example was the cryptogamic mats, the composition of which varied greatly between and within the four different vegetation types. Cryptogamic mats in wet forest sites were dominated by bryophytes (Figure 4: E). Cryptogamic mats in heathy woodland sites varied from lichen-dominated (Figure 4: F1) to bryophyte-dominated (Figure 4: F2). Cryptogamic mats were relatively rare in grassy woodlands (Figure 3). When they did occur, they were most commonly found on burnt ground (Figure 4: G). Cryptogamic mats on alpine heath sites varied from *Sphagnum*-dominated in poorly drained areas (Figure 4: H1), to mixed lichens and bryophytes in rockier, free drained areas (Figure 4: H2).

Litter varied from predominantly eucalypt leaves and bark (Figure 4: A) within wet forest sites to predominantly fine-leaved litter in the heathy woodland and alpine heath. The species producing litter also differed between vegetation types (Figure 4: B and D). Litter in grassy woodland sites varied from predominantly dead grass (Figure 4: C1) to dead grass with some leaf and bark litter (Figure 4: C2).

Amounts of bare soil were more consistent among heathy woodland sites than among wet forest sites (Figure 5 and Figure 6). Rock cover in wet forest sites was generally higher than heathy woodland sites. Cover of cryptogams was relatively similar between these two vegetation types, except for HEC and HEG which were the most recently burnt sites (< 5 years) and had a more open structure with greater cryptogam cover than the other sites. Litter cover was similar between wet forest and heathy woodland, but the leaf litter component differed. The quantities of small and large wood had the greatest contrast of all substrate factors between the wet forest and heathy woodland sites, with most of the heathy woodland sites having less of both.

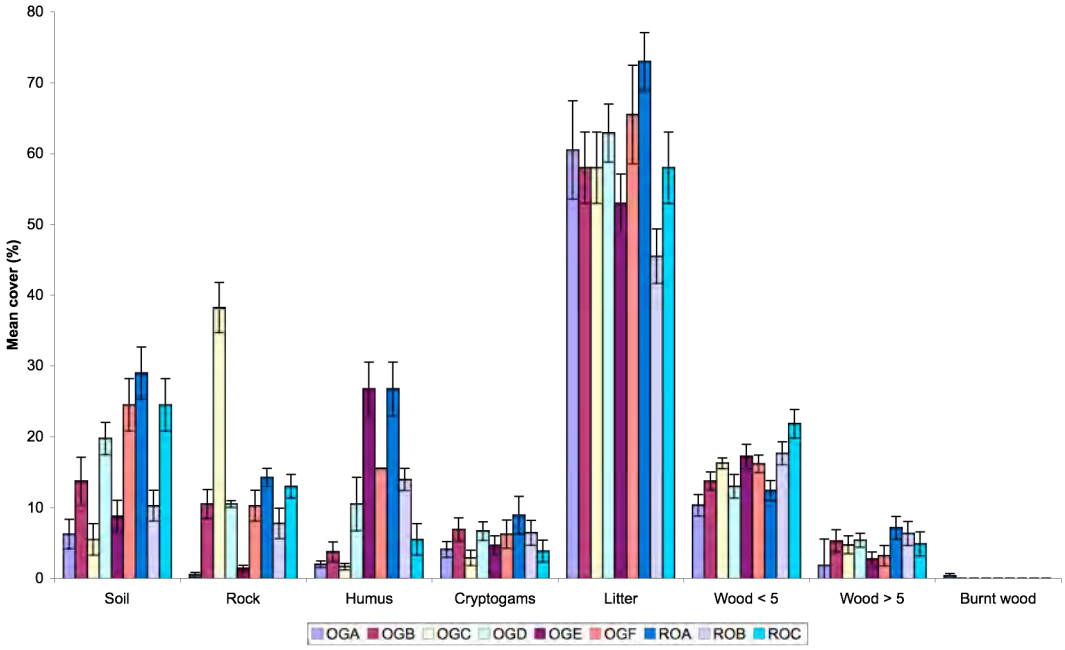


Figure 5. Mean cover (including standard error) for each substrate for wet forest. Site names in legend (site names Chapter 2, Table 1).

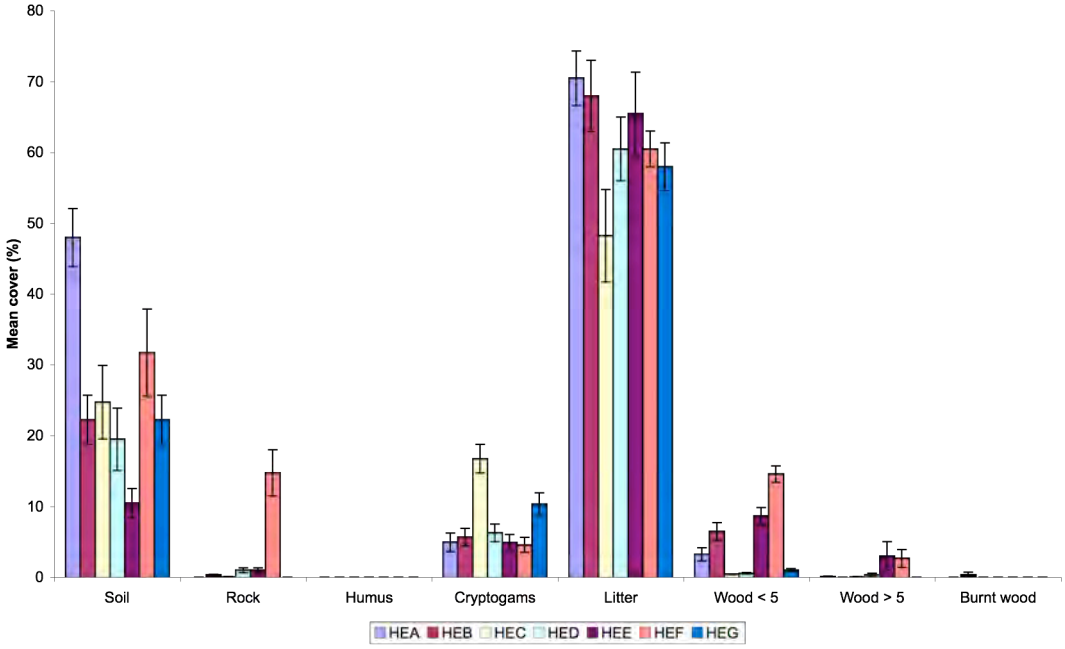


Figure 6. Mean cover (including standard error) for each substrate for heathy woodland. Site names in legend (site names Chapter 2, Table 1).

Although most substrates other than burnt wood were present on most sites, moss and macrofungal taxa were not distributed evenly across substrates and vegetation types (Table 2-3). Wet forest had the highest number of taxa of both mosses and macrofungi. All classes of substrate

in wet forest supported many cryptogam taxa. Rock and soil supported the highest number of moss taxa, followed by wood and burnt wood. For the macrofungi, soil supported the largest number of taxa in wet forest. Small wood and large wood were the substrates that supported the next greatest numbers of taxa.

Most of the taxa in heathy and grassy woodlands, and alpine heath were on soil (Table 2-3). Alpine heath also had a number of taxa found on rocks and only a few taxa found on litter or wood. Litter and wood only supported a few taxa on alpine heath sites but none on heath or grassy sites. Burnt wood supported a few moss taxa on heathy or grassy woodland sites.

For the macrofungi outside of the wet forest, heath sites supported the greatest diversity of taxa (Table 3). Again, most taxa were found on soil, then small wood and litter. A limited number of taxa were found in heath on large wood, burnt wood or bark. For the grassy woodland sites, most macrofungal taxa were found on burnt wood. A number of taxa were also found on soil and small and large wood. Six taxa were observed from litter and smooth bark. Alpine heath had the lowest number of macrofungal taxa, with most being found on soil. Nine taxa were found on litter and two taxa were found on small wood.

Table 2. Number of moss taxa observed on substrates by vegetation type.

Substrates	Wet Forest	Heathy woodland	Grassy woodland	Alpine heath
Soil	32	15	25	25
Rock	33	3	0	14
Litter	11	0	1	2
Wood	29	0	0	4
Burnt wood	28	4	5	na
Smooth barked trees and shrubs	15	0	0	0
Rough barked trees and shrubs	20	2	0	0
Total number taxa	47	15	26	25

Table 3. Number of macrofungi taxa observed on substrates by vegetation type.

Substrates	Wet Forest	Heathy woodland	Grassy woodland	Alpine heath
Soil	124	54	17	11
Litter	45	12	6	9
Wood 1-5 cm diameter	92	20	11	2
Wood > 5 cm diameter	79	8	14	na
Burnt wood	33	2	20	na
Smooth barked trees and shrubs	24	1	6	0
Rough barked trees and shrubs	12	1	0	0
Total number taxa	214	85	47	19

Four community comparison

The combination of environmental factors that produced the highest r-values was altitude, geology, canopy cover, rainfall, minimum temperature in February, slope and daily solar radiation in December (Table 4). A combination of altitude, geology and canopy cover gave nearly as high r-values, with the same ranking across the biotic groups.

In terms of combinations of substrate factors, the combination of rock and humus gave higher r-values than either rock or humus alone (Table 4). However, combinations of small wood and large wood did not increase the r-value against the vascular and woody plant groups but in combination did increase the r-values for the mosses, macrofungi and saprotrophic macrofungi combined in comparison to values when small and large wood were treated as separate categories. The highest r-values for all biotic groups resulted from a combination of rock, humus, small and large wood. Combinations of significant substrate and environmental factors did not result in higher r-values. Overall, vascular plants and woody plants had higher r-values than the mosses, macrofungi and saprotrophic macrofungi.

Individual environmental factors that had significant correlations with all six biotic groups were altitude, geology, canopy cover, mean annual rainfall, mean daily minimum and maximum temperatures for February (summer) and July (winter), site slope and mean daily solar radiation for

December (Table 5). Canopy cover had the highest r-values for the vascular plants, woody plants, non-woody plants and mosses. While the macrofungi and saprotrophic macrofungi had high r-values with canopy cover, rainfall had the highest r-value for these groups. Geology, slope, rainfall, mean daily solar radiation in December and temperature factors all had relatively high r-values. Vascular plant groups mostly had higher r-values than the macrofungi and saprotrophic macrofungi. Mosses usually had the lowest r-values for each factor. Annual radiation and mean daily radiation in June had the lowest r-values. These factors were not significant for the macrofungi and saprotrophic macrofungi.

Rock, humus, and wood (small and large) were significantly correlated with all biotic groups (Table 5). Litter was also significantly correlated with vascular plant groups (vascular plants, woody plants and non-woody plants) but had particularly low r-values. Burnt wood also had similarly low but significant correlations with vascular plants, macrofungi and saprotrophic macrofungi (Table 5).

Table 4. Partial Mantel test results for combined environmental and substrates factors tested against biotic groups within wet forest, heathy and grassy woodlands, and alpine heath. R-values include 95% confidence intervals (CI).

Test factors	Vascular plants	Woody plants	Non-woody plants	Mosses	Macrofungi	Saprophytic macrofungi
	R ± CI	R ± CI	R ± CI	R ± CI	R ± CI	R ± CI
Rock + humus	0.33 ± 0.07	0.31 ± 0.08	0.29 ± 0.08	0.25 ± 0.09	0.25 ± 0.10	0.23 ± 0.10
Small + large wood	0.47 ± 0.08	0.45 ± 0.08	0.42 ± 0.08	0.56 ± 0.09	0.29 ± 0.10	0.33 ± 0.10
Small wood + large wood + burnt wood	0.47 ± 0.08	0.46 ± 0.08	0.49 ± 0.08	0.56 ± 0.09	0.29 ± 0.10	0.34 ± 0.10
Rock + humus + small + big wood	0.55 ± 0.07	0.53 ± 0.08	0.49 ± 0.08	0.58 ± 0.09	0.37 ± 0.10	0.40 ± 0.09
All substrate factors	0.44 ± 0.07	0.43 ± 0.08	0.39 ± 0.08	0.39 ± 0.09	0.33 ± 0.09	0.34 ± 0.09
Temperatures [a]	0.51 ± 0.08	0.50 ± 0.08	0.47 ± 0.08	0.36 ± 0.09	0.55 ± 0.08	0.52 ± 0.08
Radiation [b]	0.51 ± 0.08	0.50 ± 0.08	0.47± 0.08	0.36 ± 0.08	0.55 ± 0.08	0.52 ± 0.08
Best combination of factors [c]	0.82 ± 0.08	0.81 ± 0.08	0.74 ± 0.08	0.65 ± 0.09	0.66 ± 0.09	0.65 ± 0.09
Altitude + geology + canopy	0.78 ± 0.08	0.77 ± 0.08	0.69 ± 0.08	0.66 ± 0.09	0.59 ± 0.09	0.60 ± 0.09
All environmental factors	0.78 ± 0.08	0.77 ± 0.08	0.71 ± 0.08	0.60 ± 0.09	0.64 ± 0.09	0.63 ± 0.09

Probability of all tests was < 0.001.

[a] minimum and maximum mean daily temperatures for July and February.

[b] mean daily radiation for June and December plus the mean annual radiation.

[c] Altitude, geology, canopy cover, rainfall, minimum mean daily temperature for February, slope, and mean daily solar radiation December.

Table 5. Partial Mantel test results for single environmental and substrates factors tested against biotic groups within wet forest, heathy and grassy woodlands, and alpine heath. R-values include 95% confidence intervals (CI).

Test factors	Vascular plants		Woody plants		Non-woody plants		Mosses		Macrofungi		Saprophytic macrofungi	
	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P
Rock	0.25 ± 0.08	***	0.25 ± 0.08	***	0.20 ± 0.08	***	0.10 ± 0.09	*	0.24± 0.10	***	0.20 ± 0.10	***
Humus	0.20 ± 0.06	***	0.17 ± 0.07	***	0.20 ± 0.07	***	0.33 ± 0.10	***	0.09 ± 0.12	0.09	0.11 ± 0.11	*
Litter	0.09 ± 0.07	*	0.08 ± 0.07	*	0.10 ± 0.07	*	0.01 ± 0.10	ns	0.08 ± 0.10	ns	0.05 ± 0.10	ns
Small wood	0.46 ± 0.08	***	0.44 ± 0.08	***	0.40 ± 0.08	***	0.54 ± 0.09	***	0.29 ± 0.10	***	0.33 ± 0.10	***
Large wood	0.50 ± 0.07	***	0.50 ± 0.08	***	0.45 ± 0.08	***	0.51 ± 0.10	***	0.27 ± 0.10	***	0.32 ± 0.10	***
Burnt wood	0.06 ± 0.06	*	0.06 ± 0.07	ns	0.048 ± 0.07	ns	-0.01 ± 0.11	ns	0.21 ± 0.12	**	0.18 ± 0.12	**
Altitude (m)	0.52 ± 0.07	***	0.53 ± 0.08	***	0.45 ± 0.08	***	0.30 ± 0.09	***	0.54 ± 0.10	***	0.50 ± 0.10	***
Geology	0.54 ± 0.08	***	0.54 ± 0.08	***	0.48 ± 0.083	***	0.45 ± 0.09	***	0.36± 0.09	***	0.37 ± 0.09	***
Mean percentage canopy cover	0.61 ± 0.08	***	0.61 ± 0.08	***	0.51 ± 0.08	***	0.64 ± 0.09	***	0.42 ± 0.10	***	0.47 ± 0.09	***
Mean annual rainfall (mm)	0.52 ± 0.07	***	0.54 ± 0.08	***	0.46 ± 0.08	***	0.30 ± 0.09	***	0.55 ± 0.10	***	0.50 ± 0.10	***
Mean daily maximum temperature July (°C)	0.31 ± 0.08	***	0.28 ± 0.09	***	0.30 ± 0.08	***	0.26 ± 0.08	***	0.40 ± 0.08	***	0.38 ± 0.08	***
Mean daily minimum temperature July (°C)	0.52 ± 0.08	***	0.51 ± 0.08	***	0.46 ± 0.08	***	0.36 ± 0.09	***	0.51 ± 0.09	***	0.49 ± 0.09	***
Mean daily maximum temperature Feb (°C)	0.50 ± 0.08	***	0.49 ± 0.08	***	0.45 ± 0.08	***	0.33 ± 0.09	***	0.55 ± 0.09	***	0.50 ± 0.09	***
Mean daily minimum temperature Feb (°C)	0.48 ± 0.08	***	0.47 ± 0.08	***	0.44 ± 0.08	***	0.30 ± 0.09	***	0.52 ± 0.09	***	0.47 ± 0.09	***

Table 5. Continued

Test factors	Vascular plants		Woody plants		Non-woody plants		Mosses		Macrofungi		Saprophytic macrofungi	
	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P
Slope (°)	0.50 ± 0.08	***	0.52 ± 0.08	***	0.43 ± 0.08	***	0.36 ± 0.09	***	0.37 ± 0.09	***	0.39 ± 0.09	***
Mean daily solar radiation December ($MJm^{-2}day^{-1}$)	0.52 ± 0.08	***	0.52 ± 0.08	***	0.47 ±0.08	***	0.38 ± 0.10	***	0.43 ± 0.09	***	0.44 ± 0.09	***
Mean daily solar radiation June ($MJm^{-2}day^{-1}$)	0.13 ± 0.07	**	0.14 ± 0.07	**	0.12 ± 0.07	**	0.10 ± 0.10	*	0.04 ± 0.10	ns	0.06 ± 0.10	ns
Mean annual solar radiation (MJm^{-2})	0.19 ±0.06	***	0.19 ± 0.07	***	0.18 ± 0.07	***	0.15 ± 0.10	**	0.07 ± 0.11	ns	0.10 ± 0.10	ns

Probability (P): ns = not significant, * = < 0.05, ** = < 0.01 and *** = < 0.001.

Two community correlations

Consistently, the ranks of the biotic groups resulting r-values, from highest to lowest, were vascular plants, woody plants, non-woody plants, mosses, macrofungi, saprotrophic macrofungi and ectomycorrhizal macrofungi (Table 6). The highest r-values among the combined factor tests were given by combining altitude, geology and canopy cover. When the best substrate factors and the best environmental factors were combined and tested they produced lower r-values than the altitude, geology and canopy cover combination.

Temperature factors were tested together. All tests were significantly correlated with all biotic groups (Table 6). The r-values of the combined tests were higher than the individual temperature factors alone for all biotic groups except for the ectomycorrhizal macrofungi. For the ectomycorrhizal macrofungi the minimum mean daily temperatures for February and July were significant while the maximum mean daily temperatures for February and July were not significant (Table 6). Radiation only had significant correlations with vascular plants and woody plants.

Rock, humus, small and large wood – the substrates that were significantly correlated with the biotic groups - had higher r-values when analysed in combination (Table 6) than when analysed separately (Table 7). Addition of other substrate variables that were not significant decreased the r-values.

The individually tested environmental factors that did not have any significant correlations with any of the biotic groups were slope and mean daily radiation in December. These factors were significant at the previous scale. Rainfall only had a significant relationship with non-woody plants and ectomycorrhizal macrofungi (Table 7). Geology and canopy cover were significantly correlated with all biotic groups, with the non-woody plants and ectomycorrhizal macrofungi having lower r-values.

Altitude was significantly correlated with all biotic groups except for the ectomycorrhizal macrofungi. Minimum and maximum mean daily temperatures for February (summer) and July (winter) were all significantly correlated with all biotic groups except for the ectomycorrhizal macrofungi which were only significantly correlated with the minimum temperatures. Annual radiation and mean daily radiation in June (winter) were significantly correlated with vascular plants and woody plants but not with any of the cryptogamic groups.

The mean cover of each of soil, cryptogams, litter and burnt wood did not correlate significantly with any of the biotic groups. Rock and humus both had significant correlations with the vascular plant groups (vascular plants, woody plants and non-woody plants) but with none of the moss or macrofungal groups except for the relationship between humus and ectomycorrhizal macrofungi (Table 7). This pattern also was found when rock and humus were compared (Table 6). Wood, both small and large, had significant correlations with all biotic groups. These had the highest r-values of the single substrate factor tests.

Table 6. Partial Mantel test results for combined environmental and substrates factors tested against biotic groups within wet forest and heathy woodland. R-values include 95% confidence intervals (CI).

Factors	Vascular plants		Woody plants		Non-woody plants		Mosses		Macrofungi		Saprotrophic macrofungi		Ectomycorrhizal macrofungi	
	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P
Rock + humus	0.31 ± 0.14	**	0.30 ± 0.14	**	0.25 ± 0.16	**	0.16 ± 0.19	ns	0.16 ± 0.20	ns	0.11 ± 0.21	ns	0.21± 0.25	ns
small + large wood	0.42 ± 0.17	***	0.45 ± 0.17	***	0.29 ± 0.16	**	0.42 ± 0.17	***	0.33 ± 0.18	**	0.34 ± 0.18	**	0.14 ± 0.18	ns
Rock + humus + small + large wood	0.46 ± 0.16	**	0.70 ± 0.16	**	0.35 ± 0.17	**	0.35 ± 0.18	**	0.29 ± 0.18	*	0.27 ± 0.19	*	0.22 ± 0.20	*
All substrate factors	0.29 ± 0.14	*	0.34 ± 0.14	**	0.15 ± 0.16	ns	0.28 ± 0.17	**	0.25 ± 0.18	*	0.28 ± 0.19	*	0.07 ± 0.22	ns
Temperature [a]	0.42 ± 0.16	***	0.42 ± 0.16	**	0.33 ± 0.16	**	0.37 ± 0.18	**	0.35 ± 0.19	**	0.32 ± 0.20	*	0.26 ± 0.21	*
Radiation [b]	0.17 ± 0.14	*	0.16 ± 0.15	*	0.18± 0.16	*	0.05007 ± 0.182	ns	0.01 ± 0.19	ns	0.03 ± 0.20	ns	-0.10 ± 0.24	ns
Altitude + geology + canopy cover	0.72 ± 0.16	***	0.69 ± 0.16	***	0.65 ± 0.16	***	0.66± 0.16	***	0.59 ± 0.16	***	0.55 ± 0.16	***	0.33 ± 0.17	***
All significant environmental factors [c]	0.65 ± 0.16	***	0.64 ± 0.16	***	0.57 ± 0.16	***	0.5314 ±0.166	***	0.48 ± 0.17	***	0.45 ± 0.18	***	0.21 ± 0.20	*
All environmental factors	0.61 ± 0.16	***	0.59 ± 0.16	***	0.56 ± 0.16	***	0.48 ± 0.17	***	0.43 ± 0.18	**	0.40 ± 0.18	**	0.21 ± 0.20	*

Probability (P): ns = not significant, * = <0.05, ** = <0.01 and *** = < 0.001.

[a] minimum and maximum mean daily temperatures for July and February.

[b] mean daily radiation (June) and mean annual radiation.

[c] Altitude, geology, canopy cover, minimum and maximum mean daily temperature (Feb and July), daily solar radiation Jun and annual solar radiation.

Table 7. Partial Mantel test results for single environmental and substrates factors tested against biotic groups within wet forest and heathy woodland. R-values include 95% confidence intervals (CI).

Factors	Vascular plants		Woody plants		Non-woody plants		Mosses		Macrofungi		Saprophytic macrofungi		Ectomycorrhizal macrofungi	
	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P
Rock	0.18 ± 0.13	*	0.22 ± 0.13	**	0.11 ± 0.15	ns	0.01 ± 0.18	ns	0.01 ± 0.20	ns	0.040 ± 0.21	ns	-0.09 ± 0.30	ns
Humus	0.22 ± 0.15	*	0.20 ± 0.15	*	0.21 ± 0.17	*	0.17 ± 0.20	ns	0.17 ± 0.22	ns	0.1 ± 0.23	ns	0.31 ± 0.24	*
Litter	-0.09 ± 0.15	ns	-0.06 ± 0.15	ns	-0.12 ± 0.16	ns	0.001 ± 0.18	ns	-0.01 ± 0.19	ns	0.03 ± 0.20	ns	-0.06 ± 0.23	ns
Small wood	0.38 ± 0.16	**	0.42 ± 0.16	**	0.22 ± 0.16	*	0.44 ± 0.18	***	0.33 ± 0.18	**	0.37 ± 0.19	**	0.08 ± 0.20	ns
Large wood	0.35 ± 0.16	**	0.36 ± 0.17	**	0.28 ± 0.17	**	0.30 ± 0.17	*	0.24 ± 0.18	*	0.23 ± 0.19	*	0.12 ± 0.20	ns
Altitude (m)	0.35 ± 0.14	**	0.394 ± 0.14	**	0.19 ± 0.15	*	0.37 ± 0.17	**	0.32 ± 0.17	**	0.33 ± 0.18	**	0.13 ± 0.21	ns
Geology	0.73 ± 0.16	***	0.69 ± 0.17	***	0.67 ± 0.16	***	0.68 ± 0.16	***	0.62 ± 0.17	***	0.57 ± 0.16	***	0.38± 0.18	***
Canopy cover	0.67 ± 0.17	***	0.75 ± 0.17	***	0.37 ± 0.17	**	0.76 ± 0.17	***	0.68 ± 0.17	***	0.73 ± 0.17	***	0.25 ± 0.17	**
Mean annual rainfall (mm)	0.024 ± 0.12	ns	-0.07 ± 0.12	ns	0.22 ± 0.17	*	-0.06 ± 0.18	ns	-0.07 ± 0.20	ns	-0.20 ± 0.21	ns	0.29 ± 0.29	*
Mean daily minimum temperature July (°C)	0.35 ± 0.16	**	0.33 ± 0.16	**	0.35 ± 0.17	**	0.29 ± 0.18	*	0.26 ± 0.19	*	0.20 ± 0.20	*	0.25 ± 0.20	*
Mean daily maximum temperature July (°C)	0.13 ± 0.13	*	0.25 ± 0.13	**	-0.13 ± 0.15	ns	0.24 ± 0.18	*	0.20 ± 0.19	*	0.30 ± 0.201	**	-0.13 ± 0.222	ns
Mean daily maximum temperature Feb (°C)	0.41 ± 0.16	**	0.34 ± 0.16	**	0.46 ± 0.16	***	0.31 ± 0.18	*	0.28 ± 0.18	*	0.1867 ± 0.186	*	0.35 ± 0.19	**
Mean daily minimum temperature Feb (°C)	0.37 ± 0.15	**	0.397 ± 0.15	**	0.26 ± 0.16	**	0.36 ± 0.18	**	0.32 ± 0.18	**	0.30 ± 0.19	**	0.17 ± 0.21	ns

Table 7. Continued.

Factors	Vascular plants		Woody plants		Non-woody plants		Mosses		Macrofungi		Saprophytic macrofungi		Ectomycorrhizal macrofungi	
	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P	R ± CI	P
slope	-0.11 ± 0.18	ns	-0.11 ± 0.17	ns	-0.11 ± 0.16	ns	-0.13 ± 0.17	ns	-0.13 ± 0.18	ns	-0.12 ± 0.17	ns	-0.14 ± 0.18	ns
Daily solar radiation Dec ($MJm^{-2}day^{-1}$)	-0.08 ± 0.21	ns	-0.04 ± 0.15	ns	0.06 ± 0.16	ns	-0.03 ± 0.19	ns	-0.08 ± 0.20	ns	-0.01 ± 0.15	ns	-0.06 ± 0.23	ns
Daily solar radiation June ($MJm^{-2}day^{-1}$)	0.18 ± 0.14	*	0.19 ± 0.15	*	0.15 ± 0.16	ns	0.07 ± 0.19	ns	0.04 ± 0.20	ns	0.08 ± 0.21	ns	-0.11 ± 0.24	ns
Mean annual solar radiation (MJm^{-2})	0.15 ± 0.14	*	0.17 ± 0.15	*	0.13 ± 0.16	ns	0.04 ± 0.19	ns	0.03 ± 0.20	ns	0.052 ± 0.21	ns	-0.09 ± 0.24	ns

Probability (P): ns = not significant, * = < 0.05, ** = < 0.01 and *** = < 0.001.

Discussion

Environmental factors

The three most influential factors were altitude, geology and canopy cover. Together these produced the highest r-values for tests of correlation between environmental factors and biotic groups. Altitude is a surrogate for rainfall and temperature, and geology indicates nutrient availability. These factors are classic factors which influence vascular plant growth. Canopy cover created by trees and tall shrubs is a biotic expression of the macroclimate and available nutrients. Canopy cover also affects the radiation which reaches ground level and the sub-canopy microclimate. Canopy cover not surprisingly had some of the highest correlations with the mosses and macrofungi.

Similar environmental factors to altitude, geology and canopy cover have been found to influence macrofungal communities (O'Dell *et al.* 1999; Claridge *et al.* 2000a) and bryophyte communities (Gignac 1992; Vanderpoorten & Engels 2002; Bruun *et al.* 2006; Dell & Jenkin 2006; Virtanen *et al.* 2006). Research has found that dense shade can create moist micro-climates which may be important for utilisation of substrate by cryptogams (Söderström 1988a; McAlister 1995; Mills & Macdonald 2005; Jansova & Soldan 2006; Standovar *et al.* 2006). Canopy cover has also been shown to have negative correlations with terrestrial bryophytes (Sadler & Bradfield 2000), a finding consistent with the results of the present study, wherein terrestrial bryophytes made up a lower proportion of the mosses in the shaded vegetation type. Most of the other environmental factors had significant correlations with all of the biotic groups. This confirms expectations based on the literature for vascular plants and mosses, but is the first exploration of the connection between environment and epigeous macrofungi in Australian ecosystems.

While the biotic groups showed similar responses for most factors there were a few factors where the mosses and macrofungi responded differently to the vascular plants. The non-photosynthetic nature of fungi

could explain the lack of correlation of this group with both daily radiation in June and annual radiation. However, this begs the question: why do the macrofungi and saprotrophic macrofungi have significant correlations (with relatively high r-values) for the mean daily radiation in December? It may perhaps relate to the minimum amount of moisture needed for macrofungi reproduction. In the two-community study, it was interesting that the non-woody plants (which are the understorey vascular plants) did not correlate significantly with radiation, so are responding similarly to the cryptogamic groups rather than the other vascular plant groups. Qian *et al.* (1999) also found that understorey ensemble responded in a similar manner to lignicolous cryptogams to environmental factors.

Ectomycorrhizal fungi were absent from alpine vegetation and relatively few taxa were found in grassy woodlands. Thus this ensemble could only be considered in the wet forest and heath analyses. Ectomycorrhizal fungi in the present study had non-significant or weaker correlations compared to the other biotic groups. For example, ectomycorrhizal fungi were the only ensemble to have a significant correlation with precipitation, which is in keeping with the finding of O'Dell *et al.* (1999) that ectomycorrhizal fungi are prevalent in higher rainfall areas. The fewer significant correlations may be in part be due to the smaller data set for the ectomycorrhizal fungi. Also, as found by van der Heijden *et al.* (1999), the presence of epigeous sporocarps does not necessarily indicate their relative importance of ectomycorrhizae in the rhizosphere.

Overall, the strength of the relationships of environmental factors with the mosses and the macrofungal groups were consistently lower than those of the vascular plant groups. Even the best combinations of significant factors that give high explanatory value for the plant groups have lower r-values for the cryptogamic groups. Clearly there are other factors influencing the cryptogamic groups that are not as important for the vascular plant groups. That the non-woody plants, which were predominantly understorey plants, had similar r-values to the cryptogams for many factors suggests that microclimatic factors have a strong influence on these groups. This idea is supported by the literature which

commonly states that cryptogams are strongly influenced by microclimate (Ashton 1986; Rydin *et al.* 1997; Nordén & Appelqvist 2001; Heylen *et al.* 2005; Mills & Macdonald 2005; Standovar *et al.* 2006; Pharo & Zartman 2007). Another interpretation of the association is that it is not the microclimate *per se* but rather substrate characteristics influenced by microclimate or some combination of factors (McAlister 1997; Mills & Macdonald 2004).

Substrate factors

All of the biotic groups had significant correlations with substrate cover of rock, humus, small and large wood for both the four community analyses and two community analyses. These factors in combination gave relatively high r-values, particularly for the mosses. Rock cover can be an important factor in the distribution of saxicolous bryophytes (Newmaster *et al.* 2005; Standovar *et al.* 2006; Virtanen & Oksanen 2007). Presence of humus or organic matter in soils has been shown to affect the distribution of cryptogams (Petersen 1985; Nantel & Neumann 1992; Rambo & Muir 1998; Dell & Jenkin 2006). Small and large wood had the highest individual correlations of the substrate factors with all of the biotic groups. Small and large wood are components of woody debris, the presence and diversity of which has been shown to increase the presence of cryptogams (Andersson & Hytteborn 1991; Crites & Dale 1995; Crites & Dale 1998; Mills *et al.* 2001; Arsenault 2002; Norden *et al.* 2004; Odor *et al.* 2005).

It is clear from the relative numbers of moss and macrofungal taxa found on different substrates across the four vegetation types, that similar substrate in different vegetation supported different amounts of cryptogams. Most moss and macrofungal taxa were found on the broadest range of substrates within wet forest sites. These sites differed the most from the other vegetation types by having a closed canopy, leaving the understorey shaded and moist. Moist sub-canopy conditions coincided with the highest numbers of taxa for both the mosses and macrofungi. Many authors working on cryptogams, particularly

bryophytes, have also found a link between moist environments and high species numbers (Söderström 1988b; McAlister 1995; Mills & Macdonald 2005; Dynesius & Zinko 2006; Jansova & Soldan 2006; Standovar *et al.* 2006). (Newmaster & Bell 2002) found that within clear-cut forest sites, where the substrates were exposed to dry conditions, there were few cryptogams. Sites with specific habitat elements and microclimate conditions are crucial for the presence of some threatened species (Berg *et al.* 1994; Rydin *et al.* 1997; Berglund & Jonsson 2001, 2003; Heilmann-Clausen *et al.* 2005).

Microclimate also has a strong influence on the wood decay process (Rayner & Boddy 1988). In the current study, soil and woody substrates supported the most mosses and macrofungi, with rock also supporting a high number of mosses. Wet forests had the highest quantities of woody substrates, which goes some way towards explaining their higher cryptogam species richness. Crites and Dale (1995) similarly found that old aspen mixed-wood stands which had the highest variety of woody substrates also supported the highest numbers of non-vascular species. Furthermore, wet forest has the most conducive microclimates of the four communities for the colonisation of substrates by mosses and macrofungi. Substrate and individual species interactions will be further investigated in the next chapter to gauge the extent of their influence on individual taxa.

Environmental factors had significant correlations with the biotic groups, confirming that these factors relate to the distribution of vascular plant and moss macrofungi groups. Canopy cover has a strong correlation with all the biotic groups. Canopy cover is a potential surrogate for moist microclimates which are particularly important for taxon rich cryptogamic groups. Woody debris, an important substrate for cryptogams, also had relatively high correlations with all the biotic groups. Interactions between substrate and microclimate are likely to influence the distribution of cryptogams.

References

Allen, E. B., and M. F. Allen. 1984. Competition between plants of different successional stages: mycorrhizae as regulators. Canadian Journal of Botany **62**:2625-2629.

Andersson, L. I., and H. Hytteborn. 1991. Bryophytes and decaying wood - a comparison between managed and natural forest. Holarctic Ecology **14**:121-130.

Arsenault, A. 2002. Managing coarse woody debris in British Columbia's forests: a cultural shift for professional foresters? Pages 869-878. USDA Forest Service General Technical Report. USDA Forest Service, Kamloops, B.C.

Ashton, D. H. 1986. Ecology of bryophytic communities in mature *Eucalyptus regnans* F. Muell. forest at Wallaby Creek, Victoria. Australian Journal of Botany **34**:107-129.

Bates, J. W. 2000. Mineral nutrition, substratum ecology, and pollution. Pages 248-311 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Begon, M., J. L. Harper, and C. R. Townsend 1990. Ecology - Individuals, populations and Communities. Blackwell Scientific Publications, Melbourne.

Berg, A., B. Ehnstrom, L. Gustafsson, T. Hallingback, M. Jonsell, and J. Weslien. 1994. Threatened plant, animal and fungus species in Swedish forests: distribution and habitat associations. Conservation Biology **8**:718-731.

Berglund, H., and B. G. Jonsson. 2001. Predictability of plant and fungal species richness of old-growth boreal forest islands. Journal of Vegetation Science **12**:857-866.

Berglund, H., and B. G. Jonsson. 2003. Nested plant and fungal communities: the importance of area and habitat quality in maximizing species capture in boreal old-growth forests. Biological Conservation **112**:319-328.

Boddy, L. 2001. Fungal community ecology and wood decomposition processes in angiosperms: from standing tree to complete decay of coarse woody debris. Pages 43-56 in B. G. Jonsson, and N. Kruys, editors. Ecology of woody debris in boreal forests. Blackwell Science, Oxford.

Bougher, N. L., and I. C. Tommerup. 1996. Conservation significance of ectomycorrhizal fungi in Western Australia Pages 299-308 in H. S., C. J., H. M., and G. A., editors. Gondwanan Heritage: Past, Present and Future of the Western Australian biota. Surrey Beatty & Sons, Chipping Norton.

Brundrett, M. 1991. Mycorrhizas in natural ecosystems. Advances in Ecological Research **21**:171-271.

Bruun, H. H., J. Moen, R. Virtanen, J. A. Grytnes, L. Oksanen, and A. Angerbjorn. 2006. Effects of altitude and topography on species

richness of vascular plants, bryophytes and lichens in alpine communities. Journal of Vegetation Science **17**:37-46.

Claridge, A. W., S. C. Barry, S. J. Cork, and J. M. Trappe. 2000a. Diversity and habitat relationships of hypogeous fungi. II Factors influencing the occurance and number of taxa. Biodiversity and Conservation **9**:175-199.

Claridge, A. W., S. J. Cork , and J. M. Trappe. 2000b. Diversity and habitat relationships of hypogeous fungi. I Study design, sampling techniques and general survey results. Biodiversity and Conservation **9**:151-173.

Colpaert, J. V., and K. K. Van Tchelen. 1996. Mycorrhizas and environmental stress. Pages 109-128 in J. C. Frankland, N. Magan, and G. M. Gadd, editors. Fungi and Environmental Change. Cambridge University Press, Cambridge.

Cox, C. B., and P. D. Moore 1993. Biogeography: An Ecological and Evolutionary Approach. Blackwell Scientific Publications, Cambridge, Great Britain.

Crites, S., and M. B. Dale. 1995. Relationships between nonvascular species and stand age and stand structure in aspen mixed forest in Alberta. Pages 91-114 in J. B. Stelfox, editor. Forests in Alberta. Alberta Environment Centre and Canadian Forest Service, Edmonton.

Crites, S., and M. R. T. Dale. 1998. Diversity and abundance of bryophytes, lichens, and fungi in relation to woody substrate and successional stage in aspen mixed-wood boreal forests. Canadian Journal of Botany **76**:641-651.

Dahlberg, A. 2001. Community ecology of ectomycorrhizal fungi: an advancing interdisciplinary field. New Phytologist **150**:55-562.

Dell, M., and J. Jenkin. 2006. Bryophyte distribution in Blackwood forests of the Otway Ranges, Victoria. The Victorian Naturalist **123**:255-264.

Diekmann, M., and U. Falkengren-Grerup. 1998. A new species index for forest vascular plants: development of functional indices based on mineralization rates of various forms of soil nitrogen. Journal of Ecology **86**:269-283.

Dighton, J. 1995. Nutrient cycling in different terrestrial ecosystems in relation to fungi. Canadian Journal of Botany **73**:S1349-S1360.

Dix, N. J., and J. Webster 1995. Fungal Ecology. Chapman & Hall, Cambridge.

Dynesius, M., and U. Zinko. 2006. Species richness correlations among primary producers in boreal forests. Diversity and Distributions **12**:703-713.

Eldridge, D. J., W. S. Semple, and T. B. Koen. 2000. Dynamics of cryptogamic soil crusts in a derived grassland in south-eastern Australia. Austral Ecology **25**:232-240.

Fauth, J. E., J. Bernado, M. Camara, W. J. Resetarits, J. Van Buskirk, and S. A. McCollim. 1996. Simplifying the jargon of community ecology: a conceptual approach. American Naturalist **147**:282-286.

Fensham, R. J., and H. Streimann. 1997. Broad landscape relations of the moss flora from inland dry rainforest in North Queensland, Australia. The Bryologist **100**:56-64.

Franklin, J. F. 1998. The natural, the clearcut, and the future. Pages 134-138 in J. A. Trofymow, and A. MacKinnon, editors. Proceedings of a workshop on Structure, Process, and Diversity in Successional Forests of Coastal British Columbia. Northwest Science, Victoria, British Columbia.

Franks, A. J., and D. M. Bergstrom. 2000. Corticolous bryophytes in microphyll fern forests of south-east Queensland: distribution on Antartic beech (*Nothofagus moorei*). Austral Ecology **25**:386-393.

Fraver, S., R. G. Wagner, and M. Day. 2002. Dynamics of coarse woody debris following gap harvesting in the Acadian forest of central Maine, U.S.A. Canadian Journal of Forest Research **32**:2094-2105.

Gignac, L. D. 1992. Niche structure, resource partitioning, and species interactions of mire bryophytes relative to climatic and ecological gradients in Western Canada The Bryologist **95**:406-418.

Hansen, P. A., and G. Tyler. 1992. Statistical evaluation of tree species affinity and soil preference of the macrofungal flora in south Swedish beech, oak and hornbeam forests. Cryptogam Botany **2**:355-361.

Heilmann-Clausen, J., E. Aude, and M. Christensen. 2005. Cryptogam communities on decaying deciduous wood - does tree species diversity matter? Biodiversity and Conservation **14**:2061-2078.

Heylen, O., M. Hermy, and E. Schrevens. 2005. Determinants of cryptogamic epiphyte diversity in a river Valley (Flanders). Biological Conservation **126**:371-382.

Jansova, I., and Z. Soldan. 2006. The habitat factors that affect the composition of bryophyte and lichen communities on fallen logs. Preslia **78**:67-86.

Jonsson, B. G. 2000. Availability of coarse woody debris in a Boreal old-growth *Picea abies* Forest Journal of Vegetation Science **11**:51-56.

Kellar, C., M. Short, and J. Milne. 2006. Epiphytes on *Nothofagus cunninghamii* and *Eucalyptus regnans* in a Victorian cool temperate rainforest. The Victorian Naturalist **123**:222-229.

Kendrick, B. 2000. The Fifth Kingdom. Mycologue Publications, Canada.

Kennedy, P. G., A. D. Izzo, and T. Bruns. 2003. There is high potential for the formation of common mycorrhizal networks between understorey and canopy trees in a mixed evergreen forest. Journal of Ecology **91**:1071-1080.

Kirby, K. J., S. D. Webster, and A. Antczak. 1991. Effects of forest management on stand structure and the quantity of fallen dead

wood: some British and Polish examples. Forest Ecology and Management **43**:167-174.

Kruys, N., and B. G. Jonsson. 1999. Fine woody debris is important for species richness on logs in managed boreal spruce forests of northern Sweden. Canadian Journal of Forest Research **29**:1295-1299.

Kruys, N., B. G. Jonsson, and G. Stahl. 2002. A stage-based matrix model for decay-class dynamics of woody debris. Ecological Applications **12**:773-781.

Lobel, S., J. Dengler, and C. Hobohm. 2006. Species richness of vascular plants, bryophytes and lichens in dry grasslands: the effects on environment, landscape structure and competition. Folia Geobotanica **41**:377-393.

Macdonald, S. E., L. Cuthbertson, B. Frey, T. Fenniak, L. Lazaruk, S. Kembell, S. Mills, V. Lieffers, M. B. Dale, K. Mallett, A. Munson, and D. H. Vitt. 2001. Pattern and process in Boreal Forest understory. Patterns and process of the boreal forest understory: a comparison of post-fire and post-harvest dynamics. Sustainable Forest Management Network Project.

MacKinnon, A., and J. A. Trofymow. 1998. Structure, processes, and diversity in successional forests of coastal British Columbia. Pages 1-3 in J. A. Trofymow, and A. MacKinnon, editors. Proceedings of a workshop on Structure, Process, and Diversity in Successional Forests of Coastal British Columbia. Northwest Science, Victoria, British Columbia.

May, T. W., and J. A. Simpson. 1997. Fungal diversity and ecology in eucalypt ecosystems. Pages 246-277 in J. E. Williams, and J. C. Z. Woinarski, editors. Eucalypt Ecology: Individuals to Ecosystems. Cambridge University Press, Cambridge.

McAlister, S. 1995. Species interactions and substrate specificity among log-inhabiting bryophyte species. Ecology **76**:2184-2195.

McAlister, S. 1997. Cryptogam communities on fallen logs in the Duke Forest, North Carolina. Journal of Vegetation Science **8**:115-124.

McCune, B., and A. Antos. 1981a. Correlations between forest layers in the Swan Valley, Montana. Ecology **62**:1196-1204.

McCune, B., and A. Antos. 1981b. Diversity relationships of forest layers in the Swan Valley, Montana. Bulletin of the Torrey Botanical Club **108**:354-361.

Mills, S., S. E. Macdonald, and D. H. Vitt. 2001. Factors affecting bryophyte species diversity in the boreal forest. Page 20. Pattern and process in Boreal Forest understorey. SFM Network Project, Alberta, Canada.

Mills, S. E., and S. E. Macdonald. 2004. Predictors of moss and liverwort species diversity of microsites in conifer-dominated boreal forest. Journal of Vegetation Science **15**:189-198.

Mills, S. E., and S. E. Macdonald. 2005. Factors influencing bryophyte assemblage at different scales in the western Canadian boreal forest. Bryologist **108**:86-100.

Mintab Inc. 2000. Minitab Statistical Software - 13.20. http://www.minitab.com.

Mulder, C., and D. de Zwart. 2003. Assessing fungal species sensitivity to environmental gradients by the Ellenberg indicator values of above-ground vegetation. Basic and Applied Ecology **4**:557-568.

Nantel, P., and P. Neumann. 1992. Ecology of ectomycorrhizal-basidiomycete communities on a local vegetation gradient. Ecology **73**:99-117.

Newmaster, S. G., and F. W. Bell. 2002. The effects of silviculturеal disturbances on cryptogam diversity in the boreal-mixedwood forest. Canadian Journal of Botany **32**:38-51.

Newmaster, S. G., R. J. Belland, A. Arsenault, D. H. Vitt, and T. R. Stephens. 2005. The ones we left behind: comparing plot sampling and floristic habitat sampling for estimating bryophyte diversity. Diversity and Distributions **11**:57 - 72.

Nordén, B., and T. Appelqvist. 2001. Conceptual problems of ecological continuity and its bioindicators. Biodiversity and Conservation **10**:779-791.

Norden, B., M. Ryberg, F. Gotmark, and B. Olausson. 2004. Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. Biological Conservation **117**:1-10.

O'Dell, T. E., J. F. Ammirati, and E. G. Schreiner. 1999. Species richness and abundance of ectomycorrhizal basidiomycete sporocarps on a moisture gradient in the *Tsuga heterophylla* zone. Canadian Journal of Botany **77**:1699-1711.

Odor, P., K. van Dort, E. Aude, J. Heilmann-Clausen, and M. Christensen. 2005. Diversity and composition of dead wood inhabiting bryophyte communities in European Beech Forests. Boletín de la Sociedad Española de Briología **26-27**:85-102.

Ojeda, F., T. Marañón, and J. Arroyo. 2000. Plant diversity patterns in the Aljibe Mountains (S. Spain): a comprehensive account. Biodiversity and Conservation **9**:1323-1343.

Petersen, P. M. 1985. The ecology of Danish soil inhabiting Pezizales wtih emphasis on edaphic conditions. Opera Botanica **77**:5-38.

Pharo, E. J., and A. J. Beattie. 2002. The association between substrate variability and bryophyte and lichen diversity in Eastern Australian forests. The Bryologist **105**:11-26.

Pharo, E. J., and P. A. M. Blanks. 2000. Managing a neglected component of biodiversity: a case study of bryophyte diversity in production forests of Tasmania's northeast. Australian Forestry **63**:128-135.

Pharo, E. J., and C. E. Zartman. 2007. Bryophytes in a changing landscape: The hierarchical effects of habitat fragmentation on ecological and evolutionary processes. Biological Conservation **135**:315-325.

Qian, H., K. Klinka, and X. H. Song. 1999. Cryptogams on decaying wood in old-growth forests of southern coastal British Columbia. Journal of Vegetation Science **10**:883-894.

Rambo, T. R., and P. S. Muir. 1998. Bryophyte species associations with coarse woody debris and stand ages in Oregon. The Bryologist **101**:366-376.

Rayner, A. D. M., and L. Boddy 1988. Fungal Decomposition of Wood: its Biology and Wcology. John Wiley & Sons, Brisbane.

Rydin, H., M. Diekmann, and T. Hallingback. 1997. Biological characteristics, habitat associations, and distribution of macrofungi in Sweden. Conservation Biology **11**:628-640.

Sadler, K. D., and G. E. Bradfield. 2000. Microscale distribution patterns of terrestrial bryophytes in a subalpine forest: the use of logistic regression as an interpretive tool. Community Ecology **1**:57-64.

Scholfield, W. B. 1985. Introduction to Bryology. Macmillan Publishing Company, New York.

Scott, G., T. Entwistle, T. May, and N. Stevens, editors. 1997. A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi. Environment Australia, Canberra.

Söderström, L. 1981. Distribution of bryophytes in spruce forests on hill slopes in central Sweden. Wahlenbergia **7**:141-153.

Söderström, L. 1988a. Sequence of bryophytes and lichens in relation to substrate variables of decaying coniferous wood in Northern Sweden. Nordic Journal of Botany **8**:89-97.

Söderström, L. 1988b. The occurrence of epixylic bryophyte and lichen species on an old natural and a managed forest stand in northeast Sweden. Biological Conservation **45**:169-178.

Standovar, T., P. Odor, R. Aszalos, and L. Galhidy. 2006. Sensitivity of ground layer vegetation diversity descriptors in indicating forest naturalness. Community Ecology **7**:199-209.

Tommerup, I. C., and N. L. Bougher. 2000. The role of ecotmycorrhizal fungi in nutrient cycling in temperate Australian woodlands. Pages 190-224 in R. J. Hobbs, and C. J. Yates, editors. Temperate Eucalypt Woodlands in Australia. Surrey Beatty & Sons Pty Limited, Chipping Norton, Australia.

Tommerup, I. C., N. L. Bougher, K. Syme, A. Syme, and G. Fernie. 2000. Preliminary guidelines for managing fungal biodiversity in remnant *Eucalyptus marginata* or other *Eucalyptus* forest types using fire as a tool. Ecological Management and Restoration **1**:146-147.

Turner, P. A. M., J. B. Kirkpatrick , and E. J. Pharo. 2006. Bryophyte relationships with environmental and structural variables in

Tasmanian old-growth mixed eucalypt forest. Australian Journal of Botany **54**:239-247.

van der Heijden, E. W., F. W. de Vries, and T. Kuyper, W. 1999. Mycorrhizal associations of *Salix repens* L. communities in succession of dune ecosystems. I. Above-ground and below-ground views of ectomycorrhizal fungi in relation to soil chemistry. Canadian Journal of Botany **77**:1821-1832.

van der Heijden, M. G. A., and I. R. Sanders, editors. 2002. Mycorrhizal Ecology. Springer, London.

van der Maarel, E. 1988. Vegetation dynamics: patterns in time and space. Vegetatio **77**:7-19.

van Hulst, R. 1978. On the dynamics of vegetation: patterns of environmental and vegetational change. Vegetatio **38**:65-75.

Vanderpoorten, A., and P. Engels. 2002. The effects of environmental variation on bryophytes at a regional scale. Ecography **25**:513-522.

Virtanen, R., and J. O. Oksanen. 2007. The effects of habitat connectivity on cryptogam richness in boulder metacommunity. Biological Conservation **135**:415-422.

Virtanen, R., J. O. Oksanen, L. Oksanen, and V. Y. Razzhivin. 2006. Broad-scale vegetation-environment relationships in Eurasian high-latitude areas. Journal of Vegetation Science **17**:519-528.

Watson, M. A. 1981. Patterns of microhabitat occupation of six closely related species of mosses along a complex altitudional gradient. Ecology **62**:1067-1078.

Chapter 6 - Substrate fidelity of common mosses and macrofungi

Abstract

Substrate fidelity of moss and macrofungal taxa has been implied, but few studies have addressed the issue directly. Analyses were based on the frequency of species occurrences on substrate classes. Moss and macrofungal data were compiled from four vegetation types in the Hobart area: wet forest, heathy woodland, grassy woodland and alpine heath. Additional data from a study of macrofungi in seral stages of *Eucalyptus regnans* wet forest in Victoria also was used. Substrate fidelity for 17 moss and 36 macrofungal species equivalent taxa was tested using Chi-square Goodness-of-fit substrate distribution models. All mosses and macrofungi tested had statistically significant substrate associations. Although there were some substrate generalists in both the mosses and macrofungi, most taxa showed clear preferences for a particular substrate or a group of similar substrates. The substrate preferences of macrofungi are expressions of the trophic modes of taxa. Most macrofungi had consistent substrate fidelity across time since fire, in *E. regnans* wet forest and across space, in the Hobart area. In contrast, many mosses occurred on a wide range of substrates in wet forest and were more specialised in the other vegetation types.

Introduction

Cryptogams as a group are renowned for their ability to colonise a wide range of substrates (Brodo 1973; Scott *et al.* 1997; Buck and Goffinet 2000). Individual species, however, tend to show a preference for a single or a group of related substrates (McAlister 1997; Bates 2000; Cleavitt 2001; Turner and Pharo 2005). The ability of mosses to colonise a broad range of substrates relies on the suspension of their metabolic processes when water is unavailable. Mosses are autotrophs; most

mosses obtain all their nutritional and water requirements from their substrate (Buck and Goffinet 2000; Proctor 2000a; Proctor 2000b). Fungi are heterotrophic organisms, which are also substrate dependent. Mycorrhizal fungi have symbiotic relationships with autotrophic plants, parasitic fungi take their nutritional requirements from their hosts, and saprotrophic fungi decompose their substrate for nutritional requirements.

The generalisation that many cryptogams exhibit substrate preference is generally accepted but infrequently has been confirmed empirically. In the northern hemisphere, patterns of substrate preference are better understood (Söderström 1988; Söderström 1993; McAlister 1997; Rambo and Muir 1998; Cleavitt 2001) than in Australasia, where most work on macrofungi is still in the early taxonomic stages and for mosses understanding of ecology is limited. In Australia, associations between bryophytes and substrate have been documented in a small number of studies (e.g. Ashton 1986; Pharo and Beattie 2002; Turner and Pharo 2005; Dell and Jenkin 2006; Floyed and Gibson 2006; Kellar *et al.* 2006). Much of the current knowledge of substrate and habitat requirements for individual species of mosses and macrofungi in Australasia are based on unsystematic field observations and herbarium specimens (Scott and Stone 1976; Beever *et al.* 1992; Grgurinovic 1997; Bougher and Syme 1998; Meagher and Fuhrer 2003; Fuhrer 2005; Young 2005; McCarthy 2006); substrate preferences were tested for mosses (Turner and Pharo 2005) and reported for macrofungi (Gates *et al.* 2005) in Tasmanian wet forests.

Researchers have tested cryptogam substrate association indirectly by correlating high substrate diversity and high species richness for different vegetation types (Crites and Dale 1998; Kruys and Jonsson 1999; Pharo and Beattie 2002; Turner *et al.* 2006; Lohmus *et al.* 2007). The implication is that the more substrates that are available the greater the expected species diversity of cryptogams. For example, cryptogams have preferences for different types and decay classes of coarse woody debris

(McAlister 1997; Kruys *et al.* 1999; Qian *et al.* 1999; Mills *et al.* 2001; Tedersoo *et al.* 2003; Mills and Macdonald 2004; Norden *et al.* 2004). Therefore it is inferred that the larger the number of classes of woody debris in an area the greater the overall species richness.

Conversely, shared substrates across successional stages may contribute to shared species. For example, of the 72 taxa found by Gates *et al.* (2005) on two sites at different stages of succession, 58 taxa were decomposers, of which 57 were found on wood, the most commonly shared substrate between the two sites. McMullan-Fisher *et al.* (2002) also found that many common taxa of older forest returned after burning, once the litter layer returned on sites of seven years or older. The presence of substrate can be strong enough to over-ride the macro-environment. Pharo *et al.* (2004) found that woody substrate from the previous eucalypt forest maintained bryophyte communities within a pine plantation.

From a conservation perspective, substrate is important for maintaining cryptogam diversity. Newmaster *et al.* (2005) have linked specific habitat requirements of some species with their rarity. A number of authors have confirmed this link between rarity and uncommon substrates (Berg *et al.* 1994; Kruys *et al.* 1999; Trass *et al.* 1999; Gignac and Dale 2005; Hylander *et al.* 2005; Vellak *et al.* 2007). For example, Vellak *et al.* (2007) found that the rare species were mainly specialised to one type of substrate.

This chapter assesses moss and macrofungal species substrate fidelity in four distinct Australian vegetation types and, for the macrofungi, across successional stages in *Eucalyptus regnans* forest in Victoria. It also considers whether fidelity to substrate is consistent between vegetation types and across successional stages.

Methods

Moss data were collected from the present study. Macrofungal data came from two sources: the current study (referred to as the Hobart area study) and another study of macrofungi which used similar methods and had many shared species. This other data set will be referred to as the *E. regnans* forest study, with the main findings described in McMullan-Fisher *et al.* (2002). The *E. regnans* forest study was carried out in Victorian *Eucalyptus regnans* forests of different ages since regeneration from fire (0, 2, 4, 7, 13 and 57 years). The substrate data from the *E. regnans* forest study was not included in the 2002 paper nor in the original thesis. As many of the species were also found in the Hobart study area, the opportunity was taken to base substrate data analyses on the largest comparable data set available.

Sampling methods for substrate, mosses and macrofungi for the Hobart area study are described in Chapter 2. Nine substrate types were discriminated and average cover for each class was calculated using the midpoint values of cover classes across the ten strip-plots in each site. Cover classes across all substrates may add up to more or less than 100% cover due to several layers of substrate and several substrate classes having been grouped together. Two of these substrates were not measured as separate cover classes: rough and smooth bark buttresses were included in the broader cryptogamic cover class. Numbers of buttresses for smooth and rough were counted but this data was not compariable to the cover classes. Specimens found on smooth and rough barked buttresses were collected and recorded separately so these classes have been included in the frequency results, but not the Chi-square Goodness-of-fit tests.

Analyses of moss and macrofungi taxa were only carried out on taxa that were single species, or thought to be single undescribed species. Substrate observational data were obtained for mosses and macrofungi taxa from all surveys: strip-plot, larger plot, time based and incidental surveys. Species frequency for all observations of substrates was used

for analyses.

Chi-square Goodness-of-fit analyses were used to test species fidelities to substrate. Calculations were carried out using Mintab (2000). The expectation was that if species did not have substrate preferences they could be expected to occur in proportion to the relative abundance of the substrates. This also assumes that dispersal ability and other potentially limiting factors were of no consequence. As substrates were not found in the same proportions across sites, the chance that taxa could be observed on a given substrate was calculated. The chance of occurrence at each site was calculated by firstly multiplying the each substrate type presence by the number of surveys for sites and then using these to calculate the proportional occurrence of substrates across sites. Proportions for individual substrates were used as the expected values in the Chi-square Goodness-of-fit tests.

A limitation of the Chi-square Goodness-of-fit test is that no more than 20% of the categories should have expected frequencies of less than 5 (Quinn and Keough 2002). For this reason, substrates with expected values less than 0.2 were not included in the models. Frequency data for substrates not included in the model were left out of the calculations.

The proportions of substrate used to calculate Chi-Square Goodness-of-fit tests for the mosses were soil = 0.254, rock = 0.238, total litter = 0.254 and wood = 0.254. The minimum number of observations for moss Chi-square Goodness-of-fit tests was 21. The minimum number of fungi observations required to calculate the Chi-square Goodness-of-fit tests (Table 1) was 25, 26 and 25 for taxa from the Hobart area study, both studies and the *E. regnans* forest study respectively.

Table 1 Proportions of substrate used to calculate Chi-square Goodness-of-fit tests of macrofungi for current study, both studies and the *E. regnans* forest study. Substrates are soil, total litter, small wood (≤5 cm diameter) and large wood (> 5 cm diameter).

Substrate	Hobart	Both	*E. regnans*
Soil	0.264	0.266	0.237
Litter total	0.264	0.273	0.279
Small wood	0.264	0.261	0.205
Large wood	0.208	0.200	0.279

Distribution patterns across substrate classes were calculated for species equivalent taxa that were observed eight or more times. Substrate distribution was shown for each vegetation type for the Hobart area study and the *E. regnans* forest study successional stages.

Results

Substrate distribution

The cover of substrates in the Hobart study are found in Chapter 5, Figure 3. For the *E. regnans* study the cover of different substrates changed with time since fire (Figure 1). Burnt soil and burnt wood were most abundant on recently burnt sites; this cover decreased with time since fire. While litter and small wood were absent from the most recently burnt sites, they increased in cover with time until seven years after fire when their abundance become relatively consistent. Large wood was present on all sites; it was recorded as burnt wood on the most recently burnt sites up to four years since fire. It was then present as large wood class in older sites, by which time the charcoal was covered in a layer of bryophytes.

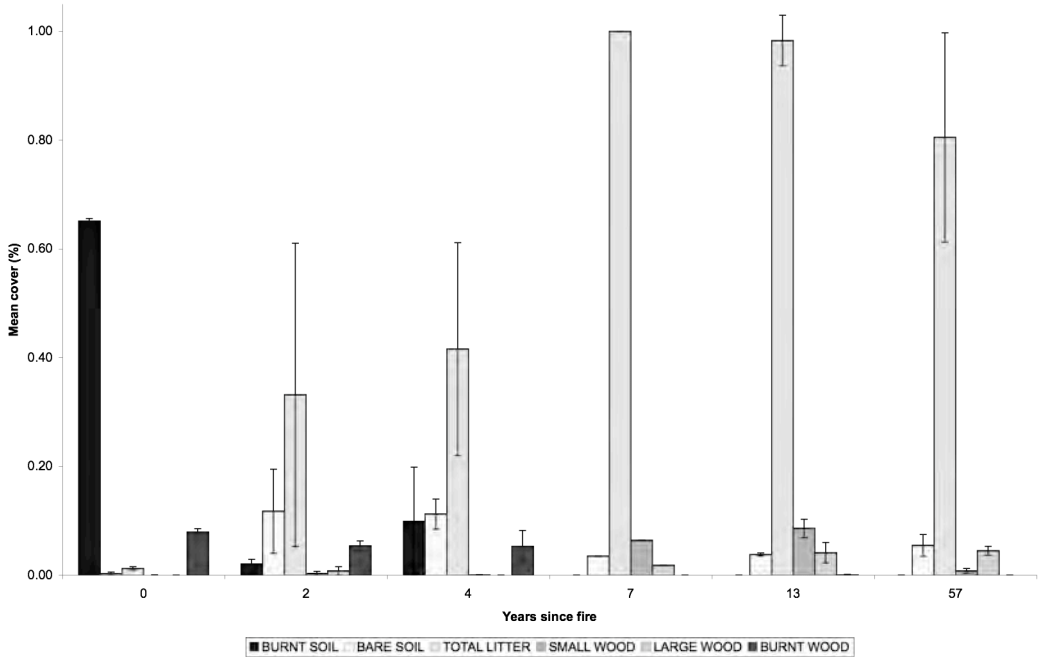


Figure 1. Mean cover of substrates from the *E. regnans* forest study on sites of different age since fire (bars are standard error, note single site for 7 years since fire, so no standard error was calculated).

Mosses

All 17 mosses analysed varied significantly in the frequency of their occurrences between the four substrates ($p < 0.05$, Appendix 8). *Racopilum cuspidigerum* var. *convolutaceum* was found on most substrates, and had a significant but lower p-value. *Acrocladium chlamydophyllum*, *Hypnum cupressiforme, Ptychomnion aciculare* and *Wijkia extenuata* were frequently observed, often on all substrates (Table 2). *Acrocladium chlamydophyllum* and *Ptychomnion aciculare* were most frequently observed on rock and soil substrates while *Hypnum cupressiforme* and *Wijkia extenuata* were most frequently observed on wood, and less frequently observed on litter (Table 2). *Tortula rubra* and *Weissia controversa* were most frequently observed on soil, occasionally on rock, but not on wood or litter (Table 2). *Breutelia affinis, Ceratodon purpureus, Fissidens leptocladus,* and *F. taylorii* were observed only on soil and rock; most observation were on soil. While *F. curvatus* var. *curvatus, F. tenellus* and *Rosulabryum billardierei* were most common on soil and rock, they were also occasionally observed on wood.

Although there are not enough observations for Chi-square Goodness-of-fit analysis for some moss species, some trends become clear when considering moss taxa that were observed eight or more times (Table 2). *Bartramia ithyphylla, Bryum argenteum, Conostomum pusillum, Grimmia pulvinata, Philonotis* sp.A, *Polytrichum commune, Pottiaceae* sp.A and *Tortula rubra* show a preference for soil. *Dicranoloma robustum, Leptotheca gaudichaudii, Rosulabryum billardierei* and *Thamnobryum pumilum* predominantly occur on soil and rock but were also observed on organic substrates. *Hypopterygium didictyon* and *Lembophyllum clandestinum* were found on many different substrates. *Camptochaete arbuscula, Dicranoloma billardierei, Lembophyllum divulsum, Orthotrichum tasmanicum* and *Rhizogonium novaehollandiae* show a preference for organic substrates.

Many of the moss taxa were found only in a single vegetation type. *Fissidens taylorii* and *Weissia controversa* were two mosses which were found in two or more vegetation types. These were found predominantly on soil, except alpine sites and were also found on rock on wet forest sites (Appendix 9). *Fissidens tenellus* showed a similar distribution but was absent from wet forest sites. Yet, on heathy woodland sites there were rare occurrences of this species on smooth and rough barked tree and shrub buttresses. *Ceratodon purpureus* was found mainly on soil across vegetation types but also occurred on rock in alpine sites and burnt wood on heathy woodland and grassy woodland sites. *Dicranoloma robustum, Leptotheca gaudichaudii* and *Polytrichum juniperinum* were most commonly found on alpine soil but were also observed from other vegetation types on soil, rock, and woody substrates. *Orthotrichum tasmanicum* was found mainly on organic substrates in wet forest, but did occur on soil on an alpine site. *Hypnum cupressiforme, Hypopterygium didictyon, Ptychomnion aciculare* and *Wijkia extenuata* were common on most substrates in wet forest and were occasionally found on soil and rock on alpine sites.

Table 2. Frequency (%) of observations (N) of mosses on different substrates. Total number of sites with substrate present are included. 'na' indicates taxa was not analysed using Chi-square Goodness-of-fit. LF = life form: 1 = upright; 2 = prostrate. Substrates: g = soil, R = rock, L = litter, W = wood, bW = burnt wood, sbk = smooth bark and rbk = rough bark.

LF	Chi^2 p-value	Mosses	N	Substrate percentages						
				g	R	L	W	bW	sbk	rbk
		Number of sites with substrate present:	32	32	30	32	32	7	17	16
1	na	Pottiaceae sp. A	12	100	0	0	0	0	0	0
2	na	*Philonotis* sp. A	13	100	0	0	0	0	0	0
1	na	*Grimmia pulvinata*	14	100	0	0	0	0	0	0
1	na	*Bryum argenteum*	17	100	0	0	0	0	0	0
1	na	*Conostomum pusillum*	17	100	0	0	0	0	0	0
1	na	*Bartramia ithyphylla*	13	92	0	8	0	0	0	0
2	< 0.001	*Breutelia affinis*	21	90	10	0	0	0	0	0
1	na	*Polytrichum commune*	17	94	6	0	0	0	0	0
1	< 0.001	*Tortula rubra*	37	92	3	0	0	3	0	3
1	< 0.001	*Rosulabryum billardierei*	44	64	23	0	7	5	0	2
1	< 0.001	*Weissia controversa*	57	91	9	0	0	0	0	0
1	< 0.001	*Fissidens tenellus*	106	70	20	0	2	5	0	4
1	< 0.001	*Fissidens taylorii*	31	90	10	0	0	0	0	0
1	< 0.001	*Fissidens leptocladus*	37	59	32	0	0	3	5	0
1	< 0.001	*Fissidens curvatus* var. *curvatus*	62	63	27	0	3	6	0	0
1	< 0.001	*Polytrichum juniperinum*	58	84	14	0	2	0	0	0
1	< 0.001	*Ceratodon purpureus*	55	80	9	0	0	11	0	0
1	na	*Leptotheca gaudichaudii*	10	60	10	0	10	20	0	0
1	na	*Dicranoloma robustum*	17	47	6	0	6	35	0	6
1	na	*Thamnobryum pumilum*	10	10	60	0	10	20	0	0
2	< 0.001	*Thuidium sparsum*	255	22	20	20	13	8	9	8
2	< 0.001	*Ptychomnion aciculare*	195	28	24	14	11	11	6	7
2	< 0.001	*Acrocladium chlamydophyllum*	223	18	27	16	14	10	7	8
2	< 0.001	*Wijkia extenuata*	229	15	21	7	22	17	8	10

Table 2. Continued

LF	Chi^2 p-value	Mosses	N	Substrate percentages						
				g	R	L	W	bW	sbk	rbk
2	0.034	*Racopilum cuspidigerum* var. *convolutaceum*	144	20	26	20	15	5	8	6
2	< 0.001	*Hypnum cupressiforme*	69	17	14	1	25	16	10	16
2	< 0.001	*Lembophyllum clandestinum*	33	21	24	3	24	12	6	9
1	na	*Orthotrichum tasmanicum*	10	10	0	0	30	0	50	10
1	na	*Hypopterygium didictyon*	15	20	20	13	13	13	0	20
1	na	*Dicranoloma billardierei*	15	20	13	0	40	20	0	7
1	na	*Orthodontium lineare*	23	9	0	0	9	57	0	26
2	na	*Rhizogonium novaehollandiae*	16	6	0	0	31	56	0	6
2	na	*Lembophyllum divulsum*	8	0	38	13	25	0	13	13
1	na	*Camptochaete arbuscula*	8	0	38	0	0	63	0	0
2	na	*Lembophyllum divulsum*	8	0	38	13	25	0	13	13

Macrofungi

For the macrofungi there were 92 species equivalent taxa which occurred on substrates eight or more times. All 38 macrofungal taxa analysed using the Chi-square Goodness-of-fit tests had significant (<0.001) substrate preferences (Table 3 and Appendix 8). The untested taxa also exhibited clear substrate distribution patterns (Table 3).

Of the 38 taxa found mainly on soil, twenty taxa were limited to soil alone. Twelve of the taxa limited to soil only were mycorrhizal: *Amanita xanthocephala, Cortinarius archeri, C. rotundisporus, Dermocybe austroveneta, Dermocybe sp.A, Fistulinella mollis, Hydnum repandum, Laccaria* sp. B, *Lactarius eucalypti* and *Russula neerimea.* Another three mycorrhizal taxa (*Cortinarius fibrillosus, Inocybe australiensis and Russula purpureoflava*) were infrequently found on litter or wood. Only *Fistulinella* aff. *prunicolor* was found most frequently on large and small wood, which is unexpected for a mycorrhizal taxon.

Laccaria lateritia was the only mycorrhizal taxon observed from burnt soil. *Laccaria lateritia,* along with *Discinella terrestris,* was predominantly found on soil but was also observed from burnt soil (9% and 12%). All of the other 10 taxa found on burnt soil were saprotrophic. Of these, five taxa were limited to burnt soil, while a further two taxa, *Peziza echinospora* and Discomycete sp.B hons, were also observed on burnt wood. *Mycena kuurkacea* was observed once on burnt soil (0.9%).

Omphalina chromacea and *Omphalina umbellifera* are lichenised fungi that were recorded from the soil but additional information from the original field observations showed that they were consistently found on soil algal crusts.

Table 3. Frequency (%) of macrofungi on different substrates. Total number of sites with substrate present are included. Data sets from A = *E. regnans* study, B = both studies and C = Hobart study. Trophic group (TC) : 1 = saprotrophic, 2 = mycorrhizal, 3 = parasitic and 4 = photosynthetic (Basidiolichen). P-value from Chi-square Goodness-of-fit tests are shown, na = indicates that this taxon was not analysed or the substrate was not recorded from the data set. * indicates addition information on this taxa in the text; # = burnt soil present, but not taxon.

Study	Number of sites with substrate present:	N	Burnt soil	Soil	Total litter	Wood 1-5	Wood >5	Burnt wood	Smooth bark	Rough bark
A		14	6	12	11	10	8	7	na	na
B		46	9#	44	40	42	29	14	17	16
C		32	3#	32	32	32	22	7	17	16

	TC	P-value	Taxa				Substrate percentages				
				N	Burnt soil	Soil	Total litter	Wood 1-5	Wood >5	Burnt wood	Smooth bark	Rough bark
A	1	na	*Laccocephalum mylittae*	8	100	0	0	0	0	0	na	na
A	1	na	*Laccocephalum sclerotinum*	24	100	0	0	0	0	0	na	na
A	1	na	*Laccocephalum tumulosum*	10	100	0	0	0	0	0	na	na
A	1	na	*Neolentinus dactyloides*	21	100	0	0	0	0	0	na	na
A	1	na	*Coprinus* sp. A hons	28	100	0	0	0	0	0	na	na
A	1	na	Discomycete sp. B hons	20	70	0	0	0	0	30	na	na
A	2	na	*Peziza echinospora*	28	71	0	0	0	0	29	na	na
B	1	< 0.001	*Discinella terrestris*	72	13	85	1	1	0	0	0	0
B	2	< 0.001	*Laccaria lateritia*	34	9	88	3	0	0	0	0	0
C	2	< 0.001	*Cortinarius fibrillosus*	112	na	98	0	1	1	0	0	0
C	2	< 0.001	*Dermocybe* sp. A	29	na	100	0	0	0	0	0	0
B	2	< 0.001	*Hydnum repandum*	75	0	100	0	0	0	0	0	0
C	2	< 0.001	*Laccaria* sp. B	113	na	100	0	0	0	0	0	0
B	2	< 0.001	*Lactarius eucalypti*	50	0	100	0	0	0	0	0	0
C	2	na	*Amanita xanthocephala*	13	na	100	0	0	0	0	0	0
C	2	na	*Clavulina* sp. B	20	na	85	5	5	5	0	0	0
C	2	na	*Coltricia cinnamomea*	12	na	100	0	0	0	0	0	0
C	2	na	*Cortinarius abnormis*	14	na	100	0	0	0	0	0	0
C	2	na	*Cortinarius archeri*	9	na	100	0	0	0	0	0	0

Table 3. Continued

Study	TC	P-value	Taxa	N	Substrate percentages						
					Burnt soil	Soil	Total litter	Wood 1-5	Wood >5	Burnt wood	Smooth bark	Rough bark
C	2	na	*Cortinarius rotundisporus*	8	na	100	0	0	0	0	0	0
B	2	na	*Dermocybe austroveneta*	14	0	100	0	0	0	0	0	0
C	2	na	*Fistulinella mollis*	22	na	100	0	0	0	0	0	0
C	2	na	*Inocybe australiensis*	24	na	88	0	12	0	0	0	0
C	2	na	*Russula neerimea*	11	na	100	0	0	0	0	0	0
C	2	na	*Russula purpureoflava*	12	na	92	0	8	0	0	0	0
C	1	< 0.001	*Agaricus* sp. A	25	na	100	0	0	0	0	0	0
C	1	< 0.001	*Lepiota* aff. *fuliginosa*	50	na	100	0	0	0	0	0	0
B	1	< 0.001	*Xerula australis*	48	0	100	0	0	0	0	0	0
C	1	< 0.001	*Rhodocollybia butyracea*	51	na	92	4	0	4	0	0	0
C	4	< 0.001	*Omphalina chromacea*	84	na	95	0	5	0	0	0	0
C	1	na	*Bovista* sp. A	22	na	100	0	0	0	0	0	0
C	1	na	*Callistosporium* sp. A	15	na	100	0	0	0	0	0	0
C	1	na	*Psilocybe subaeruginosa*	11	na	100	0	0	0	0	0	0
C	1	na	*Lepiota* aff. *haemorrhagica*	11	na	100	0	0	0	0	0	0
C	1	na	*Rhodocollybia* sp. A	9	na	100	0	0	0	0	0	0
C	1	na	*Cystolepiota* sp. A	16	na	81	13	0	6	0	0	0
C	1	na	*Hygrocybe rodwayi*	20	na	95	0	0	5	0	0	0
C	1	na	*Hygrocybe* sp. B	13	na	69	0	23	8	0	0	0
C	1	na	*Hygrotrama* sp. A	9	na	89	0	0	11	0	0	0
B	1	na	*Leotia lubrica*	17	0	94	0	0	6	0	0	0
C	4	na	*Omphalina umbellifera*	22	na	100	0	0	0	0	0	0
C	1	na	*Mycena* sp. C	11	na	73	0	27	0	0	0	0
B	1	< 0.001	*Marasmius elegans*	17	0	53	47	0	0	0	0	0
C	1	< 0.001	Discomycete sp. A	34	na	0	100	0	0	0	0	0
C	1	< 0.001	*Macrotyphula juncea*	35	na	14	80	6	0	0	0	0
C	1	< 0.001	*Marasmius* sp. A	24	na	0	100	0	0	0	0	0

Table 3. Continued

Study	TC	P-value	Taxa	N	Substrate percentages							
					Burnt soil	Soil	Total litter	Wood 1-5	Wood >5	Burnt wood	Smooth bark	Rough bark
C	1	< 0.001	*Mycena* aff. *neerimensis*	49	na	0	94	2	4	0	0	0
C	1	< 0.001	*Mycena* aff. *tallangattensis*	56	na	0	100	0	0	0	0	0
B	1	< 0.001	*Mycena austrofilopes*	107	0	4	91	4	2	0	0	0
B	1	< 0.001	*Mycena cystidiosa*	72	0	0	93	4	3	0	0	0
B	1	< 0.001	*Mycena kuurkacea*	108	na	0	94	1	4	1	0	0
C	1	< 0.001	*Mycena* sp. A	102	na	0	99	0	0	0	1	0
B	1	< 0.001	*Mycena viscidocruenta*	39	0	0	97	3	0	0	0	0
A	1	< 0.001	*Campanella olivaceonigra*	56	0	0	45	48	7	0	na	na
B	1	< 0.001	*Heterotextus peziziformis*	169	0	0	17	72	9	2	0	0
C	1	na	*Coprinus* aff. *disseminatus*	16	na	38	0	6	44	12	0	0
C	1	< 0.001	*Antrodiella citrea*	27	na	0	7	81	4	0	7	0
B	1	< 0.001	*Stereum illudens*	157	0	0	3	62	32	3	0	0
B	1	< 0.001	*Byssomerulius corium*	32	0	0	6	59	31	3	0	0
B	1	< 0.001	*Punctularia strigosozonata*	86	0	0	2	90	6	0	2	0
B	1	< 0.001	*Torrendiella clelandii*	33	0	0	6	79	12	0	3	0
B	4	< 0.001	*Marasmiellus affixus*	63	0	0	14	63	10	0	8	5
B	1	< 0.001	*Mycena austrororida*	41	0	0	17	63	20	0	0	0
B	1	na	*Melanotus hepatochrous*	10	0	0	20	80	0	0	0	0
B	1	na	*Fuligo septica*	10	0	0	50	0	40	10	0	0
A	1	na	*Crepidotus variabilus*	13	0	0	23	54	23	0	na	na
B	1	na	*Crepidotus eucalyptorum*	38	0	0	0	50	47	3	0	0
C	1	na	*Pholiota multicingulata*	25	na	8	4	44	32	4	8	0
C	1	na	*Lachnum lachnoderma*	23	na	0	9	91	0	0	0	0
C	1	na	*Crepidotus* aff. *nephrodes*	8	na	0	0	75	13	13	0	0
C	1	na	*Stereum hirsutum*	13	na	0	0	85	15	0	0	0
B	1	< 0.001	*Mycena interrupta*	65	0	0	5	35	58	2	0	0
B	1	< 0.001	*Panellus stipticus*	37	0	0	0	24	65	11	0	0
B	3	< 0.001	*Tremella fuciformis*	34	0	0	0	29	65	6	0	0

Table 3. Continued

Study	TC	P-value	Taxa	Substrate percentages								
				N	Burnt soil	Soil	Total litter	Wood 1-5	Wood >5	Burnt wood	Smooth bark	Rough bark
C	1	< 0.001	*Collybia* aff. *eucalyptorum*	27	na	4	0	11	48	15	4	19
B	1	na	*Gloiocephala* sp. A *	22	0	0	18	36	27	0	18	0
A	1	na	*Xylaria* sp. B	13	0	0	0	54	46	0	na	na
B	1	na	*Galerina patagonica*	13	0	0	8	23	46	23	0	0
B	1	na	*Psathyrella echinata*	44	0	0	0	2	84	14	0	0
B	1	na	*Trametes versicolor*	23	0	0	0	17	65	17	0	0
C	1	na	*Mycena nargan*	23	na	0	13	22	57	9	0	0
C	1	na	*Phellinus wahlbergii*	16	na	0	0	0	63	13	0	25
C	1	na	*Mycena kurramulla*	14	na	14	0	36	50	0	0	0
C	2	na	*Fistulinella* aff. *prunicolor*	14	na	14	0	21	64	0	0	0
A	1	na	*Dictyopanus pusillus*	13	0	0	0	31	62	8	na	na
C	1	na	*Hypholoma fasciculare*	13	na	0	0	23	77	0	0	0
C	1	na	*Hygrocybe graminicolor*	10	na	10	30	10	40	10	0	0
B	1	na	*Pycnoporus cinnabarinus*	16	0	0	0	6	19	75	0	0
C	3	na	*Tremella* sp. A	14	na	0	0	7	0	93	0	0
A	1	na	*Schizophyllum commune*	24	4	0	0	0	8	88	na	na
C	1	na	*Hohenbuehelia* aff. *clelandii*	9	na	0	0	11	22	0	0	67
C	1	na	Discomycete sp. D *	18	na	0	17	6	0	0	78	0

The remaining twenty two saprotrophic taxa that showed a preference for soil were: *Agaricus* sp. A, *Bovista sp. A, Callistosporium* sp. A, *Clavulina* sp. B*, Coltricia cinnamomea, Cystolepiota* sp. A, *Discinella terrestris, Hygrocybe rodwayi, Hygrocybe* sp. B, *Hygrotrama* sp. A*, Leotia lubrica, Lepiota* aff. *fuliginosa, Lepiota* aff. *haemorrhagica, Psilocybe subaeruginosa, Rhodocollybia butyracea, Rhodocollybia* sp. A and *Xerula australis*. These species, found ≥ 69% of the time on the soil, also occurred on litter and small and large wood but did not occur on burnt wood or buttresses.

The saprotrophic taxa that were found predominantly on organic substrates, but with no specific preference, included *Crepidotus eucalyptorum, C. variabilus, Dictyopanus pusillus, Fuligo septica, Galerina patagonica, Hygrocybe graminicolor, Mycena* sp. C, *Stereum hirsutum* and *Xylaria* sp. B*.*

Macrotyphula aff. *juncea, Marasmius elegans, Marasmius sp. A, Mycena* aff. *tallangattensis, M.* aff. *neerimensis, M. austrofilopes, M. cystidiosa, M. kuurkea, M.* sp. A and *Mycena viscidocruenta* were species with a strong preference for litter (≥ 80%) but were also occasionally found on small and large wood and soil.

Saprotrophic taxa found on woody substrates generally preferred small and large wood and burnt wood and included *Collybia* aff. *eucalyptorum*, *Crepidotus* aff. *nephrodes*, *Galerina patagonica*, *Melanotus hepatochrous*, *Mycena nargan*, *Mycena interrupta*, *Pholiota multicingulata* and *Polypore* sp. A. These taxa, while being on woody substrates ≥ 80% of the time, were occasionally observed on litter, and smooth and rough barked buttresses. Small wood (1-5 cm diameter) was favoured by *Antrodiella citrea*, *Byssomerulius corium*, *Heterotextus peziziformis*, *Lachnum lachnoderma*, *Marasmiellus affixus*, *Mycena austroroida*, *Punctularia strigosozonata*, *Stereum illudens*, and *Torrendiella clelandii*.

Larger (≥ 5 cm diameter) wood was favoured by *Hypholoma fasciculare, Panellus stipticus, Psathyrella echinata, Trametes versicolor* and *Tremella fuciformis.* The species *Dictyopanus pusillus, Pycnoporus coccineus* and *Trametes hirsuta* were observed from large wood, some of which had been burnt. *Pycnoporus cinnabarinus*, *Schizophyllum commune* and *Tremella* sp. A favoured burnt wood.

Some fungi (designated by an asterisk in Table 3) showed fidelity to some specific substrates within the broad substrate classes. *Gloiocephala* sp. A and *Discomycete* sp. D, were always found on the bark component of the substrate, the size and form of which dictated the substrate class, so these taxa probably have a bark preference.

Some of the macrofungi found mainly on litter, specifically leaf litter. These taxa included *Discomycete* sp. A, *Macrotyphula* aff. *juncea* and many of the *Marasmius* species such as *Marasmius* sp. A. *Discomycete* sp. A was only found on *Orites acicularis* leaf litter.

Individual taxa showed clear and consistent substrate preferences across vegetation types and across time within wet forest (Appendix 10). One of the few exceptions to this pattern was *Mycena interrupta*, which in the *E. regnans* forest study was found ten times on large wood and four times on small wood, while in the Hobart area study it was found 24 times on large wood and 20 times on small wood on the wet forest sites and once on burnt wood on a heathy woodland site.

Taxa from the *E. regnans* forest study that were only observed on sites in the year of the fire included *Laccocephalum mylittae, L. sclerotinum, L. tumulosum* and *Neolentinus dactyloides*. *Coprinus* sp. A, from the *E. regnans* study, was also predominantly observed from the year of the fire but was also observed on burnt ground two and four years after fire. *Peziza echinospora* and Discomycete sp. B (from the *E. regnans* study) were observed from both burnt soil and burnt wood in the year of the fire.

Discussion

All of the macrofungi and mosses tested had significant substrate associations, thus confirming for a number of species the statements in substrate notes in field guides and the taxonomic literature (Scott and Stone 1976; Beever *et al.* 1992; Grgurinovic 1997; Wood 1997; Young and Wood 1997; Bougher and Syme 1998; Wood 2001; Beever *et al.* 2002; Grgurinovic 2003; Klazenga 2003; McCarthy 2006). Many of the macrofungi were found on a broader range of organic substrates than suggested by the literature.

Macrofungi

Few fungi were common on both abiotic and organic substrates. The present study confirms many of the assumptions made about fungal distributions based on the trophic group; for example, many of the macrofungi found on soil are mycorrhizal. There are occasional instances when mycorrhizal fungi were found on substrates other than soil. To illustrate, *Inocybe australiensis* was occasionally found on small wood, which is consistant with the finding of Tedersoo *et al.* (2003) that some mycorrhizal taxa fruit-bodies are found on larger woody debris.

The saprotrophic macrofungal substrate preferences are more diverse. There were a number of suites of fungi found on particular substrate groups: those macrofungi that prefer litter, or small wood or large wood and otherwise a few substrate generalists such as those macrofungi with a preference for any woody substrate. The saprotrophic macrofungi with soil preferences (Table 3) had higher fidelity to soil than other saprotrophic fungi and were rarely observed on other substrates (Appendix 10). Gates and Ratkowsky (2005) found that 89% of macrofungal taxa were restricted to soil only or wood only. However, in the present study, macrofungi found on organic substrates mostly occurred on at least two or more substrate classes. Part of this difference between studies may arise from the broader substrate classes used by

Gates and Ratkowsky (2005), although many taxa were found on both litter and wood classes in the present study.

Many of the saprotrophic macrofungi showed not only a preference for a type of substrate, but also for a size. For example *Punctularia strigosozonata* and *Stereum illudens*, although they were also observed from other woody substrate classes, were most commonly found on small wood. Other authors have also found that fine woody debris was particularly important for the occurrence of some fungi (Kruys and Jonsson 1999; Norden *et al.* 2004). Some taxa had such strict substrate preferences that they were confined to sites containing only that specific substrate.

Mosses

Most mosses exhibited a wider substrate range than the macrofungi, which was expected as mosses are autotrophic. The exception to this was a group of mosses found predominantly on abiotic substrates. The mosses had less consistent substrate fidelity across vegetation types and the number of mosses found on a wide range of substrates outside of wet forest was limited. Most mosses on the heathy woodland, grassy woodland and alpine sites were most frequent on abiotic substrates.

Amongst the predominantly wet forest mosses, a group of prostrate mosses was found on a wide range of substrates. Several authors (Gustafsson *et al.* 2005; Hylander *et al.* 2005; Meier *et al.* 2005; Odor *et al.* 2005; Lohmus *et al.* 2007) have suggested that, in moist and shaded environments, bryophytes are found on a broader range of substrates than in drier and or more insolated situations, although this has rarely been proven (Cleavitt 2001; Cleavitt 2002). Cleavitt (2002) showed that, while different taxa do exhibit different light and desiccation tolerances, species commonly found in shaded and moist environments are not necessarily intolerant to high insolation or drought.

The present study shows that many mosses exhibit less specific substrate preferences in wet forest than other vegetation types. This finding may

explain why Turner and Pharo's (2005) study of bryophytes in wet Tasmanian forest of different age classes found that relatively few (43 of 239) bryophyte taxa showed significant relationships with one or more substrate classes. About a third of the moss species being tested were common to both data sets.

The data of Turner and Pharo (2005) is consistent with the present study's finding that *Dicranoloma billardieri*, *Hypnum cupressiforme, Leptotheca gaudichaudii, Ptychomnion aciculare, Rhizogonium novae-hollandiae, Rosulabryum billardieri, Thuidium sparsum* and *Wijkia extenuata* had positive substrate associations and were found on a number of substrate classes including soil, rock, logs, fallen branches, stumps and tree buttresses. The species found to have positive substrate associations in the present study, but not by Turner and Pharo (2005), were *Acrocladium chlamydophyllum, Ceratodon purpureus, Fissidens taylori, F. tenellus, Polytrichum juniperinum* and *Racopilum cuspidigerum* var. *convolutaceum.* This discrepancy may have arisen from the narrow substrate classes used by Turner and Pharo (2005), with only 116 substrate classes with individual Chi-square tests for each substrate and species, compared to the four substrate classes used in the Chi-square Goodness-of-fit tests for species used in the present study.

Substrate distribution

There were a number of relatively rare substrates at a landscape scale that were present on sites. Although a periodically locally common phenomenon due to the nature of Australia's fire patterns (Gill *et al.* 1981; Griffiths 1992; Reid *et al.* 1999), burnt substrates are relatively rare across the landscape. A number of macrofungal species showed preferences for burnt substrates or recently burnt sites. For example, from the *E. regnans* forest study a number of taxa were observed only from burnt soil and the most recently burnt sites. The absence of *Discomycete* sp. B, *Laccocephalum mylittae, Laccocephalum sclerotinum, Laccocephalum tumulosum* and *Neolentinus dactyloides* from the two and four years since fire sites indicate that for some species it may not be the presence of a specific substrate that determines their distribution, but

rather a specific trigger like the fire itself. *Peziza echinospora* was found predominantly on burnt soil but was also observed on burnt wood. Observations of this species were also limited to sites within a year of the burning event; These findings are consistent with those of Robinson and Bougher (2003).

Other species show a true preference for particular substrates. For example while *Coprinius* sp. A (*E. regnans* study taxon) was most common on burnt soil on recently burnt sites, it was also occasionally found on the burnt soil of sites burnt two and four years ago, making it more likely that this taxa was responding to the presence of the burnt substrate rather than the fire event.

Some of the taxa exhibited a preference for specific substrates while others were found on a wider range of substrates, a phenomenon also observed by McAlister (1997) for mosses. For example, of the macrofungi found on organic substrates, there were a number that showed a litter preference; many of these were *Mycena* taxa. There were also suites with preferences for small wood, large wood, burnt wood, soil and burnt soil.

For macrofungal taxa observed from a number of vegetation types or across a number of age classes of wet forest in the *E. regnans* forest study, all taxa except *Mycena interrupta* showed the same substrate range and preference. *Mycena interrupta* shows a preference for large wood in the *E. regnans* forest study, whilst in the Hobart study it is found at a similar frequency on both large and small wood.

Large wood was a relatively uncommon substrate type in all vegetation types except for wet forest sites. The European literature insists on the need for retaining areas with large logs and stumps, typical of old growth forests, for a number of rare red listed fungi and mosses (Söderström 1988; Andersson and Hytteborn 1991; Trass *et al.* 1999; Siitonen 2001; Siitonen *et al.* 2005). Similarly older, large-sized living trees had a higher diversity of fungi than their smaller and younger counterparts (Hopkins 2005). It can be seen here that woody substrates are preferred by a

large number of macrofungi, together making up about half of the number of species equivalent taxa found in the present study. For maintenance of diversity of cryptogams generally, retention of all types of woody substrate is important (Kruys *et al.* 1999; Norden *et al.* 2004; Lohmus *et al.* 2007).

There were clearly suites of macrofungi and mosses with similar substrate preferences. These substrate classes may be useful units to allow management of different substrates and their associated organisms. The results of the present study support the proposition of some researchers (May 1997; Jonsson *et al.* 2005) that substrate management is important to maintain cryptogam diversity.

For the first time in Australia significant associations of 53 species of moss and macrofungi with substrates have been confirmed. Although there are some substrate generalists in both the mosses and macrofungi, many taxa showed clear preferences for particular substrates or group of like substrates. Most of the macrofungi exhibited substrate fidelity across vegetation types and successional stages of *E. regnans* forest, while moss substrate fidelity seemed to be influenced by vegetation type.

References

Andersson LI, Hytteborn H (1991) Bryophytes and decaying wood - a comparison between managed and natural forest. *Holarctic Ecology* **14**, 121-130.

Ashton DH (1986) Ecology of bryophytic communities in mature *Eucalyptus regnans* F. Muell. forest at Wallaby Creek, Victoria. *Australian Journal of Botany* **34**, 107-129.

Bates JW (2000) Mineral nutrition, substratum ecology, and pollution. In 'Bryophyte Biology'. (Eds AJ Shaw and B Goffinet) pp. 248-311. (Cambridge University Press: Cambridge)

Beever J, Allison KW, Child J (1992) 'The Mosses of New Zealand.' (University of Otago Press: Dunedin)

Beever J, Malcolm B, Malcolm N (2002) 'The moss genus *Fissidens* in New Zealand: an illustrated key.' (Micro-Optics Press: Nelson, New Zealand.)

Berg A, Ehnstrom B, Gustafsson L, Hallingback T, Jonsell M, Weslien J (1994) Threatened plant, animal and fungus species in Swedish forests: distribution and habitat associations. *Conservation Biology* **8**, 718-731.

Bougher NL, Syme K (1998) 'Fungi of Southern Australia.' (University of Western Australia Press)

Brodo IM (1973) Substrate ecology. In 'The Lichens'. (Eds V Ahmadjian and ME Hale) pp. 401-441. (Academic Press: London)

Buck WR, Goffinet B (2000) Morphology and classification of mosses. In 'Bryophyte Biology'. (Eds AJ Shaw and B Goffinet) pp. 71-123. (Cambridge University Press: Cambridge)

Cleavitt NL (2001) Disentangling moss species limitations: the role of physiologically based substrate specificity for six species occurring on substrates with varying pH and percent organic matter. *The Bryologist* **104**, 59-68.

Crites S, Dale MRT (1998) Diversity and abundance of bryophytes, lichens, and fungi in relation to woody substrate and successional stage in aspen mixed-wood boreal forests. *Canadian Journal of Botany* **76**, 641-651.

Dell M, Jenkin J (2006) Bryophyte distribution in Blackwood forests of the Otway Ranges, Victoria. *The Victorian Naturalist* **123**, 255-264.

Floyed AB, Gibson M (2006) Epiphytic bryophytes of *Dicksonia antarctica* Labill. from selected pockets of Cool Temperate Rainforest, Central Highlands, Victoria. *The Victorian Naturalist* **123**, 229-235.

Fuhrer B (2005) 'A field guide to Australian Fungi.' (Bloomings Books: Melbourne)

Gates GM, Ratkowsky DA, Grove SJ (2005) A comparison of macrofungi in young silvicultural regeneration and mature forest at the Warra LTER site in the southern forests of Tasmania. *Tasforests* **16**, 127-152.

Gignac LD, Dale MRT (2005) Effects of fragment size and habitat heterogeneity on cryptogam diversity in the low-boreal forest of western Canada. *The Bryologist* **108**, 50-66.

Gill AM, Groves RH, Noble IR (1981) 'Fire and the Australian Biota.' (Australian Academy of Science: South Australia)

Grgurinovic CA (1997) 'Larger Fungi of South Australia.' (Botanic Gardens of Adelaide and State Herbarium: Adelaide, South Australia)

Grgurinovic CA (2003) 'The Genus *Mycena* in South-eastern Australia.' (Fungal Diversity Press and Australian Biological Resources Study: Canberra)

Griffiths T (1992) 'Secrets of the Forest: Discovering History in Melbourne's Ash Range.' (Allen & Unwin: Melbourne)

Gustafsson L, Applegren L, Nordin A (2005) Biodiversity value of potential forest fertilisation stands, as assessed by red-listed and 'signal' bryophytes and lichens. *Silva Fennica* **39**, 191-200.

Hopkins MS (2005) Wood-decay fungi and saproxylic beetles association with living *Eucalyptus obliqua* trees: early results from studies at the Warra LTER site, Tasmania. *Tasforests* **16**, 111-125.

Hylander K, Dynesius M, Jonsson BG, Nilsson C (2005) Substrate form determines the fate of bryophytes in riparian buffer strips. *Ecological Applications* **15**, 647-688.

Jonsson BG, Kruys N, Ranius T (2005) Ecology of species living on dead wood - lessons for dead wood management. *Silva Fennica* **39**, 289-309.

Kellar C, Short M, Milne J (2006) Epiphytes on *Nothofagus cunninghamiiI* and *Eucalyptus regnans* in a Victorian cool temperate rainforest. *The Victorian Naturalist* **123**, 222-229.

Klazenga N (2003) A revision of the Australasian species of *Dicranoloma* (Bryophyta, Dicranaceae). *Australian Systematic Botany* **16**, 427-471.

Kruys N, Fries C, Jonsson BG, Lamas T, Stahl G (1999) Wood-inhabiting cryptogams on dead Norway spruce (*Picea abies)* trees in managed Swedish boreal forests. *Canadian Journal of Forest Research* **29**, 178-186.

Kruys N, Jonsson BG (1999) Fine woody debris is important for species richness on logs in managed boreal spruce forests of northern Sweden. *Canadian Journal of Forest Research* **29**, 1295-1299.

Lohmus A, Lohmus P, Vellak K (2007) Substratum diversity explains landscape-scale co-variation in the species-richness of bryophytes and lichens. *Biological Conservation* **135**, 404-414.

May TW (1997) Fungi. In 'A Conservation overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi' pp. 49-74. (Wildlife Australia)

McAlister S (1997) Cryptogam communities on fallen logs in the Duke Forest, North Carolina. *Journal of Vegetation Science* **8**, 115-124.

McCarthy PM (2006) 'Flora of Australia 51 - Mosses 1.' Flora of Australia (ABRS and CSIRO Publishing: Canberra and Melbourne)

McMullan-Fisher SJM, May TW, Keane PJ (2002) The macrofungal community and fire in a mountain Ash forest in southern Australia. *Fungal Diversity* **10**, 57-76.

Meagher D, Fuhrer B (2003) 'A Field Guide to the Mosses and Allied Plants of Southern Australia.' (ABRS and FNCV: Canberra)

Meier E, Paal J, Liira J, Juriado I (2005) Influence of tree stand age and management on the species diversity in Estonian eutrophic alvar and boreo-nemoral *Pinus sylvestris* forests. *Scandinavian Journal of Forest Research* **20**, 135-144.

Mills S, Macdonald SE, Vitt DH (2001) Factors affecting bryophyte species diversity in the boreal forest. In 'Pattern and process in Boreal Forest understory' pp. 20. (SFM Network Project)

Mills SE, Macdonald SE (2004) Predictors of moss and liverwort species diversity of microsites in conifer-dominated boreal forest. *Journal of Vegetation Science* **15**, 189-198.

Mintab Inc (2000) Minitab Statistical Software - 13.20. In http://www.minitab.com.

Newmaster SG, Belland RJ, Arsenault A, Vitt DH, Stephens TR (2005) The ones we left behind: comparing plot sampling and floristic habitat sampling for estimating bryophyte diversity. *Diversity and Distributions* **11**, 57 - 72.

Norden B, Ryberg M, Gotmark F, Olausson B (2004) Relative importance of coarse and fine woody debris for the diversity of wood-inhabiting fungi in temperate broadleaf forests. *Biological Conservation* **117**, 1-10.

Odor P, van Dort K, Aude E, Heilmann-Clausen J, Christensen M (2005) Diversity and composition of dead wood inhabiting bryophyte communities in European Beech Forests. *Boletín de la Sociedad Española de Briología* **26-27**, 85-102.

Pharo EJ, Beattie AJ (2002) The association between substrate variability and bryophyte and lichen diversity in Eastern Australian forests. *The Bryologist* **105**, 11-26.

Pharo EJ, Lindenmayer DB, Taws N (2004) The effects of large-scale fragmentation on bryophytes in temperate forests. *Journal of Applied Ecology* **41**, 910-921.

Proctor MCF (2000a) Mosses and alternative adaptation to life on land. *New Phytologist* **148**, 1-6.

Proctor MCF (2000b) Physiological ecology. In 'Bryophyte Biology'. (Eds AJ Shaw and B Goffinet) pp. 225-147. (Cambridge University Press: Cambridge)

Qian H, Klinka K, Song XH (1999) Cryptogams on decaying wood in old-growth forests of southern coastal British Columbia. *Journal of Vegetation Science* **10**, 883-894.

Quinn GP, Keough MJ (2002) 'Experimental Design and Data Analysis for Biologists.' (Cambridge University Press: Cambridge)

Rambo TR, Muir PS (1998) Bryophyte species associations with coarse woody debris and stand ages in Oregon. *The Bryologist* **101**, 366-376.

Reid JB, Hill RS, Brown MJ, Hovenden MJ (1999) 'Vegetation of Tasmania.' (Australian Biological Resources Study: Tasmania)

Robinson RM, Bougher NL (2003) The response of fungi to fire in Jarrah (*Eucalyptus marginata*) and Karri (*Eucalyptus diversicolor*) forests of south-west Western Australia. In 'Fire in Ecosystems of South-west Western Australia: Impacts and Management'. (Eds I Abbott and N Burrows) pp. 269-289. (Backhuys Publishers: Leiden)

Scott G, Entwistle T, May T, Stevens N (1997) 'A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi.' (Wildlife Australia)

Scott GAM, Stone IG (1976) 'The Mosses of Southern Australia.' (Academic Press: London)

Siitonen J (2001) Forest management, coarse woody debris and saproxylic organisims: Fennoscandian boreal forest example. In 'Ecology of Woody Debris in Boreal Forests'. (Eds BG Jonsson and N Kruys) pp. 11-42. (Blackwell Science: Oxford)

Siitonen J, Lehtinen A, Siitonen M (2005) Effects of forest edges on the distribution, abundance, and regional persistence of wood-rotting fungi. *Conservation Biology* **19**, 250-260.

Söderström L (1988) Sequence of bryophytes and lichens in relation to substrate variables of decaying coniferous wood in Northern Sweden. *Nordic Journal of Botany* **8**, 89-97.

Söderström L (1993) Substrate preference in some forest bryophytes: a quantitative study. *Lindbergia. A Journal of Bryology* **18**, 98-103.

Tedersoo L, Koljalg U, Hallenberg N, Larsson K (2003) Fine scale distribution of ectomycorrhizal fungi and roots across substrate layers including coarse woody debrisin a mixed forest. *New Phytologist* **159**, 153-165.

Trass H, Vellak K, Ingerpuu N (1999) Floristical and ecological properties for identifying of primeval forests in Estonia. *Annales Botanici Fennici* **36**, 67-80.

Turner PAM, Kirkpatrick JB, Pharo EJ (2006) Bryophyte relationships with environmental and structural variables in Tasmanian old-growth mixed eucalypt forest. *Australian Journal of Botany* **54**, 239-247.

Turner PAM, Pharo EJ (2005) Influence of substrate type and forest age on bryophyte species distribution in Tasmania mixed forest. *The Bryologist* **108**, 67-85.

Vellak K, Vellak A, Ingerpuu N (2007) Reasons for moss rarity: Study in three neighbouring countries. *Biological Conservation* **135**, 360-368.

Wood AE (1997) Studies in the genus *Amanita* (Agaricales) in Australia. *Australian Systematic Botany* **10**, 723-854.

Wood AE (2001) Studies in the Genus *Galerina* (Agaricales) in Australia. *Australian Systematic Botany* **14**, 615-676.

Young AM (2005) 'A Field Guide to the Fungi of Australia.' (University of New South Wales Press: Sydney)

Young AM, Wood AE (1997) Studies on the Hygrophoraceae (Fungi, Holobasidiomycetes, Agaricales) of Australia. *Australian Systematic Botany* **10**, 911-1030.

Chapter 7 – Which site selection methods adequately reserve mosses and macrofungi?

Abstract

The aim was to test the usefulness of different data sets as surrogates for the selection of sites for reservation. Site selection methods (iterative, optimisation, fully random, and stratified random), were compared for their effectiveness for the conservation of different biotic groups (vascular plants, woody plants, mosses and macrofungi). The effectiveness of different data sets (all taxa combined and all named taxa) for capturing other groups was determined. Taxa recorded from a single site (singleton taxa) made up about a quarter of the total taxa across the three taxonomic groups. Full selection of taxa from the 32 sites required 26 sites for the vascular plants, 18 sites for the woody plants, 14 sites for the mosses, 22 sites for the macrofungi, 29 sites for 'named taxa' of all groups and 30 sites for 'all taxa'. The minimum reservation sets were the same using the iterative and optimisation approaches.

When only 3 sites (~10%) were selected for reservation there was little commonality in site selection between taxonomic groups. When 10 sites (~30% of sites) were to be selected at least 48% of all taxa were selected by all approaches. At the ~30% proportion of sites the vascular plant set resulted in better capture of the other two groups than use of either of the moss or macrofungi selections. At this proportion of sites, the selection using all taxa from the three groups combined had the greatest success across the three taxonomic groups with 78%, 82% and 88% of the vascular plants, mosses and macrofungi selected.

Land managers are unlikely to have access to such comprehensive diversity data sets. It is therefore reassuring that selections based on only named species from the three taxonomic groups combined and at

random by vegetation type selections were almost as successful as the 'all taxa' selections, at this target proportion of sites.

Introduction

Current global goals for conservation areas include reservation targets of 10% of each of the worlds ecoregions (Shafer 1990; United Nations Environment Programme 2004; Convention on Biological Diversity 2007) although most empirical research suggests that 30% or more of ecosystems are required if systems are to be self-maintaining (Margules *et al.* 1988; Solomon *et al.* 2003; Stewart *et al.* 2007). These conservation area goals are based on politics as much as science (Kirkpatrick 1998; Kirkpatrick 1999; Sarkar *et al.* 2006), and some authors question the usefulness of general targets rather than considering the requirements of the particular ecosystems that are being managed (Soule & Sanjayan 1998; Solomon *et al.* 2003). Nevertheless, conservation area targets are an everyday part of conservation planning around the globe, and are used in Australia at the state and federal levels (Environment Australia 2001).

Much conservation research has been undertaken on larger, more charismatic organisms like mammals, birds and some vascular plants (Lamoreux *et al.* 2006). Findings from this research could fairly be expected to translate poorly to different, and taxonomically difficult, groups such as the cryptogams (Hawksworth 1995; Hawksworth 1997; Moore *et al.* 2001; Buchanan & May 2003; May 2003; Hallingback 2007; Hylander 2007; Mueller & Schmit 2007; Norden *et al.* 2007). Cryptogams are so poorly understood that awareness of their conservation requirements is very low, particularly in Australia. For example the national framework for Australian conservation rarely mentions cryptogams, their conservation requirements are not specifically considered within it, and nor does it recognise their contributions to ecosystem function (Natural Resource Management 2007). The working assumption is that poorly understood groups will be conserved under the umbrella of other taxa (Andelman & Fagan 2000; Roberge & Angelstam

2004). The World Conservation Union (IUCN) has recognised that some groups may need conservation management beyond the umbrella of current conservation efforts and has set up a number of special working groups under the Species Survival Commission (SSC) including the Bryophyte and Fungi Specialist Groups (Hallingback & Hodgetts 2000; International Union for Conservation of Nature Species Survival Commission 2007).

One of the goals of conservation planning is to maximise conservation outcomes with limited resources (Pressey 1999; Margules & Pressey 2000; Wilson *et al.* 2005; Sarkar *et al.* 2006). (For an extensive review of the concepts, issues and tools of systematic conservation planning see (Sarkar *et al.* 2006).) One planning tool is 'minimum set selection'. Some procedures for this use heuristic algorithms, while others use approximate optimisation routines (Pressey 2002; Sarkar *et al.* 2006).

In cases where there are few data on target organisms, one approach to conservation planning has been to use surrogate species or groups as the basis for reserve selection. This approach has been in use since the 1960s (Caro & O'Doherty 1999; Poiani *et al.* 2001; Favreau *et al.* 2006), but there has been debate on its usefulness in conservation (Caro & O'Doherty 1999; Favreau *et al.* 2006). This ongoing debate has partly resulted from definitional problems (Caro and O'Doherty 1999) and the common lack of empirical testing of surrogates for their proposed use (Favreau *et al.* 2006). Saetersdal *et al.* (2005) showed that when indicator species, which included cryptogams, were tested, predictive power was geographically limited.

In Tasmania much was done during the 1990s to assess reservation adequacy for vascular plant communities and species (Kirkpatrick 1990; Kirkpatrick *et al.* 1991a; Kirkpatrick *et al.* 1991b; Kirkpatrick & Brown 1994; Kirkpatrick *et al.* 1995). Nevertheless, Mendel and Kirkpatrick (2002) showed that, although by 1997 some 30% of Tasmania was protected from logging, stock grazing and land clearance, many plant communities were still not adequately reserved. At that time 131 native

Tasmanian plants and 47 Tasmanian plant communities were not adequately reserved or protected (Kirkpatrick *et al.* 1997). Some research has been carried out on the adequacy of representation of bryophytes in Tasmanian reserves (Moscal & Kirkpatrick 1992; Brown *et al.* 1994; Moscal *et al.* 1997), with 24 areas being recommended as priority areas for the reservation of bryophytes. No research on the adequacy of reserves for macrofungi in Tasmania or the rest of Australia has been published.

This chapter will use a variety of reserve selection procedures (listed below) to compare the adequacy of reservation that can be achieved for vascular plants, mosses and macrofungi. Because all sites, bar one, are within a conservation reserve on either private or public land, the question of choosing sites for protection does not have a direct, practical application. However, it is rare to have relatively comprehensive data sets for vascular plants, mosses and macrofungi from the same sites. These data therefore provide an opportunity to test the effectiveness of the various procedures and, importantly, to test the effectiveness of surrogates in conservation planning. Sets of sites selected for representation of all vascular plants, mosses and macrofungi, and combined data sets, are compared using fully random, stratified random, iterative and optimisation techniques, at different reservation targets. These analyses are used to answer the following questions:

1) do outcomes vary by method;
2) do selections based on particular taxonomic groups cover other taxonomic groups;
3) how is surrogacy affected by reservation target levels?

Methods

Thirty-two sites, including 10 strip-plots, in four vegetation types (wet forest, heathy woodland, grassy woodland and alpine heath) were surveyed as described in Chapter 2. Presence-absence data sets for all four vegetation types were used for analyses in this chapter. The data were compiled from all of the surveys of (1) vascular plants, (2) mosses,

and (3) macrofungi. Three other data sets were also compiled: (4) 'all taxa' which is the sum of the vascular plants, mosses and macrofungi data sets; (5) 'all named species' which includes all the vascular plants, mosses and macrofungi which were able to be given a binomial (this does not include taxa which were considered species complexes, nor taxa with strong affinities to named taxa); and (6) 'woody plants' which includes all trees and shrubs from within the vascular plants data. The distribution of woody plants dominates the categorisation of vegetation in Tasmania and is therefore a potentially useful surrogate group.

Two methods of site selection were employed: an iterative technique and optimisation. In addition, selections of sets of sites that satisfied targets were made using a fully randomised sequence and a randomised sequence stratified by vegetation.

In the iterative technique, sets of sites were selected using the PATN (Belbin 2003a) reserve set subroutine MSET. MSET uses a heuristic algorithm (Belbin 2003b). For each of the six data sets, sets of sites were selected across all the four communities. Sites were chosen based on site species richness, after sites and species selected previously were removed from the data set at each selection step (Kirkpatrick 1983). This type of algorithm was described by Pressey (1999) as a 'progressive richness algorithm' and by its creator as an 'iterative' technique (Kirkpatrick 1983), which is the term used here. As this was an exercise rather than a real case, it was decided that each taxon only needed to be reserved once. In reality, when choosing sites for reservation, targets might be higher or vary between organisms based on their biological and ecological characteristics.

Optimisation algorithms are useful when comparing different reservation scenarios as they produce or approximate optimal solutions (Pressey *et al.* 1996). For site selection by optimisation, the number of taxa captured for each combination of sites was determined using an automated computer script (Turner 2007). The least number of sites that satisfied a target was selected because this results in a true optimisation, something

which is not necessarily achieved using the iterative procedure. Three sites (~10% of the total) and 10 sites (~30% of the total) were optimised, selecting the combination of sites with the maximum number of taxa at these selection levels.

To determine the minimum number of sites necessary to capture all the taxa the sites with singleton taxa necessarily must be included (Margules *et al.* 1988; Kirkpatrick *et al.* 2007). The sites containing singleton taxa were selected and then the optimisation script was used to elicit the smallest number of further sites required for complete reservation of taxa.

For the fully random selection, sites were selected without replacement such that each site was only selected once. A random selection of sites to achieve targets was also stratified by vegetation type. In the stratification, the order of vegetation types was randomised once, and then a random site within each vegetation type was selected at this first stage, followed by repeats of this procedure, with sites being selected without replacement. There were a number of ways that the stratified random site selection could have been carried out. For example, each vegetation type could have been selected so that proportions reflected the amounts of each vegetation type for Tasmania or so that poorly-reserved vegetation types were selected in a higher proportion. These types of consideration are beyond the scope of this chapter, so the simple aim of this analysis was to compare selections of equal numbers of sites from each vegetation type with the results of the optimisation and iterative techniques. Both fully random and random by vegetation types selections were run for 100 iterations and a mean result was calculated with 95% confidence intervals.

Results

Distribution of taxa across sites

Taxa found on one or two sites are in similar proportions for the vascular plants, mosses and macrofungi (Table 1). Singletons (taxa found on only one site) were about a quarter of the taxa and doubletons (taxa found on two sites only) were 14-18% of the taxa. These are likely to be underestimates of infrequent taxa, due to the data collection and identification processes, where taxa unlikely to be named yet were lumped together. More vascular plants were found on 3-5 sites than for the mosses and macrofungi, while similar percentages of each group were found on 6-10 sites. Mosses had particularly high numbers of common taxa, with 17% of taxa being found on 11-26 sites.

Table 1. Proportion (%) of taxa occurring on different numbers of sites for vascular plants, mosses and macrofungi.

Number of sites	Vascular plants	Mosses	Macrofungi
1	25	23	26
2	14	14	18
3-5	37	25	28
6-10	23	21	22
11-26	1	17	6

Singletons and full reservation

Within the full reservation sets, sites that contain singleton taxa are irreplaceable (Table 2). For 'all taxa' and 'all named taxa', 30 and 29 sites respectively are irreplaceable for the full reservation. For the vascular plants and woody plants, 26 and 14 sites respectively are irreplaceable. For the mosses and macrofungi, 11 and 20 sites respectively are irreplaceable.

The distribution of irreplaceable sites was different for the different taxonomic groups. For all vascular plants, none of the grassy woodland sites were irreplaceable, while for the woody plants, mosses and macrofungi, half of the grassy woodland sites were irreplaceable. For the macrofungi, all of the nine wet forest sites were irreplaceable, while in

the same vegetation, eight, four and six sites for vascular plants, woody plants and mosses respectively were irreplaceable. For all the taxonomic groups, except when analysed together, at least half of the alpine sites were irreplaceable.

The iterative and optimisation site selection techniques produced nearly identical selections of sites when the target was each taxon to be reserved at least once (Table 3). This is to be expected when the replaceability of sites is considered, due to the location of singletons in the different taxonomic groups (Table 2). Where there were differences in the site selections between the two selection methods (Table 3), these were either grassy woodland or alpine heath sites which had the fewest singletons from the three taxonomic groups. For the three other data sets ('all taxa', 'all named species' and vascular plants), the selection of all sites that contained singleton taxa fully reserved all component taxa. Some additional sites were required for full selection for the woody plants, mosses and macrofungi.

Table 2. Number of taxa at each site for groups. The proportion (%) of taxa found only at the site is in parentheses. Vegetation type (V): WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath. Site names Chapter 2, Table 1. Groups are: AT = all taxa, ANS = all named species, WP = woody plants, P = vascular plants, M = mosses and F = macrofungi.

V	Site	AT	ANS	WP	P	M	F
WF	OGA	126 (7)	74 (5)	16 (6)	27 (7)	18 (6)	81 (7)
WF	OGB	141 (8)	86 (10)	11 (9)	29 (17)	22 (0)	89 (7)
WF	OGC	98 (2)	65 (2)	14 (0)	22 (5)	18 (0)	58 (2)
WF	OGD	101 (5)	58 (3)	9 (0)	12 (8)	21 (5)	67 (4)
WF	OGE	137 (5)	79 (5)	13 (0)	24 (4)	19 (5)	93 (5)
WF	OGF	113 (8)	68 (9)	18 (17)	29 (17)	24 (13)	60 (2)
WF	ROA	173 (12)	86 (8)	11 (0)	26 (8)	30 (10)	116 (13)
WF	ROB	138 (4)	77 (1)	11 (0)	20 (0)	20 (0)	99 (6)
WF	ROC	103 (10)	62 (11)	16 (13)	24 (13)	13 (8)	67 (9)
HE	HEA	67 (4)	44 (7)	20 (0)	30 (10)	4 (0)	34 (0)
HE	HEB	65 (6)	43 (5)	17 (6)	32 (6)	1 (0)	32 (6)
HE	HEC	74 (5)	50 (4)	17 (6)	39 (5)	6 (0)	30 (7)
HE	HED	98 (7)	74 (8)	23 (9)	58 (10)	14 (7)	26 (0)
HE	HEE	63 (3)	43 (2)	21 (0)	33 (0)	3 (33)	27 (4)
HE	HEF	66 (5)	41 (5)	23 (9)	39 (5)	3 (0)	24 (4)
HE	HEG	62 (5)	46 (4)	16 (6)	31 (6)	4 (0)	27 (4)
GR	GRA	93 (8)	74 (9)	18 (0)	65 (11)	15 (0)	13 (0)
GR	GRB	82 (1)	67 (1)	23 (4)	60 (2)	13 (0)	9 (0)
GR	GRC	94 (6)	78 (4)	24 (8)	69 (6)	18 (6)	7 (14)
GR	GRD	51 (10)	39 (8)	9 (0)	36 (6)	10 (20)	5 (20)
GR	GRE	54 (9)	42 (10)	7 (0)	35 (14)	12 (0)	7 (0)
GR	GRF	59 (5)	47 (4)	8 (13)	44 (7)	11 (0)	4 (0)
MT	MTA	45 (9)	37 (11)	18 (6)	31 (10)	10 (0)	4 (25)
MT	MTB	42 (2)	34 (3)	18 (0)	27 (0)	13 (8)	2 (0)
MT	MTC	47 (6)	34 (9)	20 (10)	30 (10)	14 (0)	3 (0)
MT	MTD	49 (2)	38 (3)	12 (0)	34 (3)	13 (0)	2 (0)
MT	MTE	37 (0)	25 (0)	11 (0)	24 (0)	10 (0)	3 (0)
MT	MTF	48 (2)	34 (3)	14 (0)	30 (0)	10 (0)	8 (13)
MT	MTG	58 (0)	42 (0)	16 (0)	40 (0)	12 (0)	6 (0)
MT	MTH	55 (5)	46 (7)	15 (0)	41 (5)	12 (0)	2 (50)
MT	MTI	49 (4)	36 (0)	11 (0)	36 (3)	10 (0)	3 (33)
MT	MTJ	38 (3)	28 (4)	13 (0)	28 (4)	6 (0)	4 (0)
	Total	594 (25)	403 (23)	110 (19)	284 (25)	71 (23)	234 (26)

Table 3. Site selections resulting from optimisation for 3 sites (~10% of total sites), 10 sites (~30% of total sites), complete optimisation and complete reservation using iterative technique. For optimisation results + indicates site is selected for target. For the iterative results the site selections are in priority order, numbered from one as the highest priority. Data sets used for site selection include AT = all taxa, ANS = all named species, WP = woody plants, P = vascular plants, M = mosses and F = macrofungi. Vegetation types (V): WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath. Site names Chapter 2, Table 1.

		3 sites (~10%) optimisation						10 Sites (~30%) optimisation						Complete optimisation						Iterative selection					
V	Site	AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F
WF	OGA	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+	+	+	14	15	12	18	9	6
WF	OGB	+	-	-	-	-	+	+	+	-	+	-	+	+	+	+	+	-	+	3	4	14	4	-	3
WF	OGC	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	+	-	+	25	25	6	21	-	13
WF	OGD	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+	19	17	-	22	5	10
WF	OGE	-	-	-	-	-	-	+	-	-	-	+	+	+	+	-	+	+	+	6	8	-	23	10	5
WF	OGF	-	-	-	-	-	-	-	-	+	+	+	-	+	+	+	+	+	+	12	12	4	10	4	15
WF	ROA	+	+	-	-	+	+	+	+	-	+	+	+	+	+	-	+	+	+	1	1	-	7	1	1
WF	ROB	-	-	-	-	-	+	+	-	-	-	-	+	+	+	-	-	-	+	10	21	-	-	-	2
WF	ROC	-	-	-	-	-	-	-	+	+	-	-	+	+	+	+	+	+	+	11	13	7	14	11	7
HE	HEA	-	-	+	+	-	-	-	-	+	+	-	+	+	+	-	+	-	-	16	5	3	12	-	-
HE	HEB	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	+	20	19	17	3	-	11
HE	HEC	-	-	-	-	-	-	+	-	-	-	-	+	+	+	+	+	-	+	5	10	15	16	-	4
HE	HED	-	-	-	-	-	-	-	+	+	+	-	-	+	+	+	+	+	+	15	11	11	9	12	19
HE	HEE	-	-	-	-	-	-	-	+	-	-	-	-	+	+	+	-	+	+	26	16	-	-	13	16
HE	HEF	-	-	-	-	-	-	+	-	+	-	-	-	+	+	+	+	-	+	9	22	5	13	-	8
HE	HEG	-	-	-	-	-	-	-	+	-	-	-	-	+	+	+	+	-	+	23	23	18	19	-	14

Table 3. Continued.

V	Site	3 sites (~10%) optimisation						10 Sites (~30%) optimisation						Complete optimisation						Iterative selection					
		AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F	AT	ANS	WP	P	M	F
GR	GRA	-	-	-	-	-	-	-	+	-	+	-	-	+	+	-	+	-	-	13	6	-	5	-	18
GR	GRB	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	+	27	26	8	24	-	-
GR	GRC	+	+	+	+	+	-	+	-	+	+	+	-	+	+	+	+	+	-	2	2	1	1	2	12
GR	GRD	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	+	+	+	17	18	-	20	7	17
GR	GRE	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	-	+	8	9	10	8	8	-
GR	GRF	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	-	24	24	16	15	-	-
MT	MTA	-	-	-	-	-	-	-	+	-	+	-	-	+	+	+	+	-	+	18	7	13	11	-	20
MT	MTB	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	28	27	-	-	6	-
MT	MTC	-	-	+	-	-	-	-	-	+	-	-	-	+	+	+	+	+	-	22	14	2	6	-	-
MT	MTD	-	-	-	-	+	-	-	-	-	-	+	-	+	+	-	+	-	-	29	28	-	25	3	-
MT	MTE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
MT	MTF	-	-	-	-	-	-	+	-	-	-	-	+	+	+	-	-	-	+	7	29	-	-	14	9
MT	MTG	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	20	-	-	-	-
MT	MTH	-	+	-	+	-	-	+	+	-	+	-	-	+	+	+	+	-	+	4	3	9	2	-	21
MT	MTI	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	+	21	-	-	17	-	22
MT	MTJ	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	-	30	30	-	26	-	-
No of sites		3	3	3	3	3	3	10	10	10	10	10	10	30	29	18	26	14	22	30	30	18	26	14	22

Full reservation of the vascular plant taxa, which requires 26 sites, also reserves 97% of moss and macrofungal taxa (Table 4). The accumulation curve for the vascular plants is smooth due to the steady increase of taxa with the addition of sites (Figure 1). The rate of addition of new taxa decreases as more sites are added for all three groups. The macrofungal and moss curves for the vascular plants selection are more stepped, especially with the early selection of sites (Figure 1). This is due to both the mosses and macrofungi having highest species richness in the wet forest sites, so when these sites were added the species richness increases sharply.

Table 4 Proportion (%) of taxa reserved using different biotic data sets for site selections using the iterative technique across all sites. Number of sites to reserve each taxon at least once in parentheses.

Data set	Vascular plants	Mosses	Macrofungi
All taxa (30)	100	100	100
All named species (30)	99	100	100
Woody plants (18)	91	82	80
Vascular plants (26)	100	97	97
Mosses (14)	75	100	80
Macrofungi (22)	91	94	100

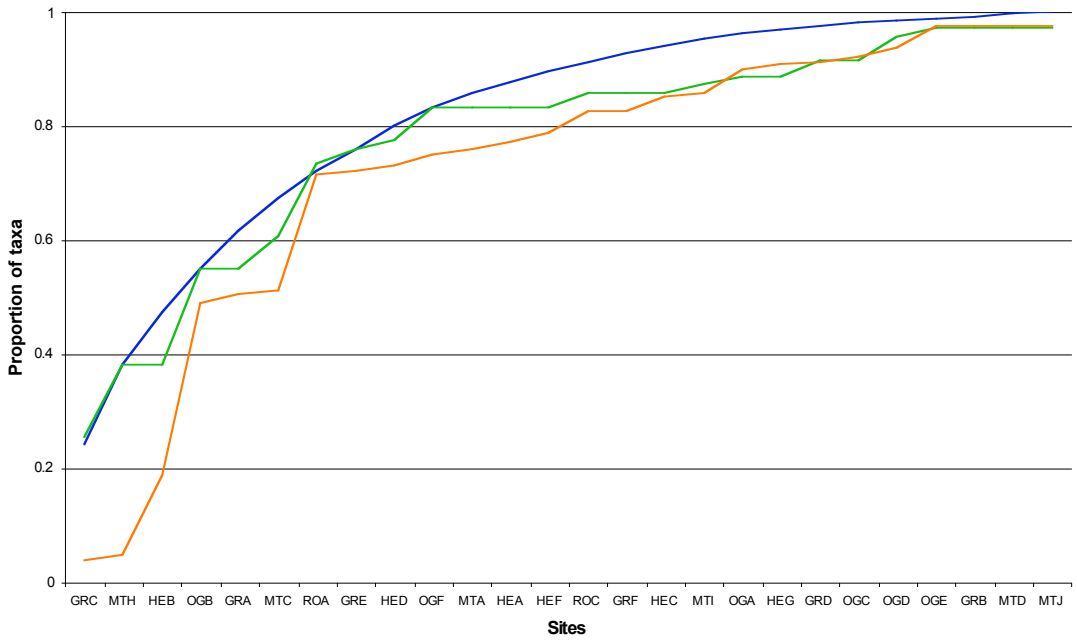


Figure 1. Cumulative proportion of taxa selected using the iterative technique, based on the vascular plants data set. Proportion reserved of vascular plants = blue, mosses = green and macrofungi = orange.

Use of the woody plants reserves 91% of the vascular plants, 82% of the mosses and 80% of the macrofungi. Use of the moss or macrofungal data sets for full reservation also reserves three-quarters or more of all three taxonomic groups.

Selection of sites using the 'named species' data set fully reserves 'all taxa' from the mosses and macrofungi (Table 4). These are the best reservation percentages, other than when either the mosses or macrofungi data alone are used for site selection for themselves. The use of the 'named species' data set also reserves 99% of vascular plants.

Vascular plants (90%) and mosses (74%) had the highest proportion of named species (Table 5), with only 40% of macrofungal taxa being formally named. The pattern of site irreplaceability for 'all taxa' is nearly mirrored by the 'named species' only data set (Table 5). Many of the singleton taxa were also named species (Table 5). This is partly due to the identification strategy. Taxa judged unlikely to be consistently identifiable were lumped together.

Table 5. Proportion (%) of named species for groups on sites. For singleton taxa for each site the number of named species over total singleton taxa are in parentheses. Site names Chapter 2, Table 1.

Site	All taxa	Vascular plants	Mosses	Macrofungi
OGA	59 (4/9)	96 (1/2)	78 (1/1)	42 (2/6)
OGB	61 (9/11)	90 (4/5)	77 (0/0)	48 (5/6)
OGC	66 (1/2)	91 (1/1)	83 (0/0)	52 (0/1)
OGD	57 (2/5)	100 (1/1)	86 (0/1)	42 (1/3)
OGE	58 (4/7)	83 (0/1)	79 (0/1)	47 (4/5)
OGF	60 (6/9)	93 (4/5)	83 (2/3)	35 (0/1)
ROA	50 (8/20)	81 (2/2)	80 (2/3)	36 (4/15)
ROB	57 (2/6)	85 (0/0)	85 (0/0)	44 (2/6)
ROC	60 (7/10)	88 (3/3)	85 (1/1)	45 (3/6)
HEA	66 (3/3)	100 (3/3)	25 (0/0)	38 (0/0)
HEB	66 (2/4)	94 (2/2)	0 (0/0)	41 (0/2)
HEC	68 (2/4)	95 (2/2)	50 (0/0)	33 (0/2)
HED	76 (6/7)	90 (4/6)	79 (1/1)	42 (0/0)
HEE	68 (1/2)	94 (0/0)	33 (1/1)	41 (0/1)
HEF	62 (2/3)	87 (2/2)	33 (0/0)	25 (0/1)
HEG	74 (2/3)	100 (2/2)	75 (0/0)	44 (0/1)

Table 5. Continued

Site	All taxa	Vascular plants	Mosses	Macrofungi
GRA	80 (7/7)	88 (6/7)	67 (0/0)	54 (0/0)
GRB	82 (1/1)	92 (1/1)	62 (0/0)	44 (0/0)
GRC	83 (3/6)	88 (2/4)	72 (1/1)	57 (0/1)
GRD	78 (2/5)	89 (1/2)	60 (1/2)	40 (0/1)
GRE	80 (4/5)	86 (4/5)	67 (0/0)	71 (0/0)
GRF	81 (2/3)	84 (2/3)	64 (0/0)	100 (0/0)
MTA	82 (4/4)	97 (3/3)	50 (0/0)	50 (1/1)
MTB	81 (1/1)	96 (0/0)	54 (1/1)	50 (0/0)
MTC	72 (3/3)	90 (3/3)	50 (0/0)	0 (0/0)
MTD	78 (1/1)	94 (0/1)	38 (0/0)	50 (0/0)
MTE	68 (0/0)	83 (0/0)	40 (0/0)	33 (0/0)
MTF	71 (1/1)	93 (0/0)	40 (0/0)	25 (1/1)
MTG	72 (0/0)	88 (0/0)	42 (0/0)	33 (0/0)
MTH	84 (3/3)	95 (2/2)	50 (0/0)	50 (1/1)
MTI	73 (0/2)	86 (0/1)	50 (0/0)	0 (0/1)
MTJ	74 (1/1)	89 (1/1)	33 (0/0)	25 (0/0)

Limited site selections

The iterative and optimisation techniques exhibit similar selection patterns at ~10% and ~30% of sites (Figures 2-3 and Table 6). As expected each biotic data set produced the best reservation for its own group. Surrogate group selections were always less effective. Use of the vascular plants data set gave the better reservation across the other groups. Steep increases in the proportion of taxa selected occur when sites with high numbers of taxa from that group were included. This is particularly pronounced for intermediate site additions of the mosses and macrofungi (Figures 2-3). In some cases for the optimisation results, when one site was changed for another it resulted in decreases in the proportion of reserved taxa for some of the biotic groups (Figure 3). For example where the moss data was used for the reserve selection, the proportion of macrofungi decreased when site ROA was replaced with OGD (Figure 3: middle).

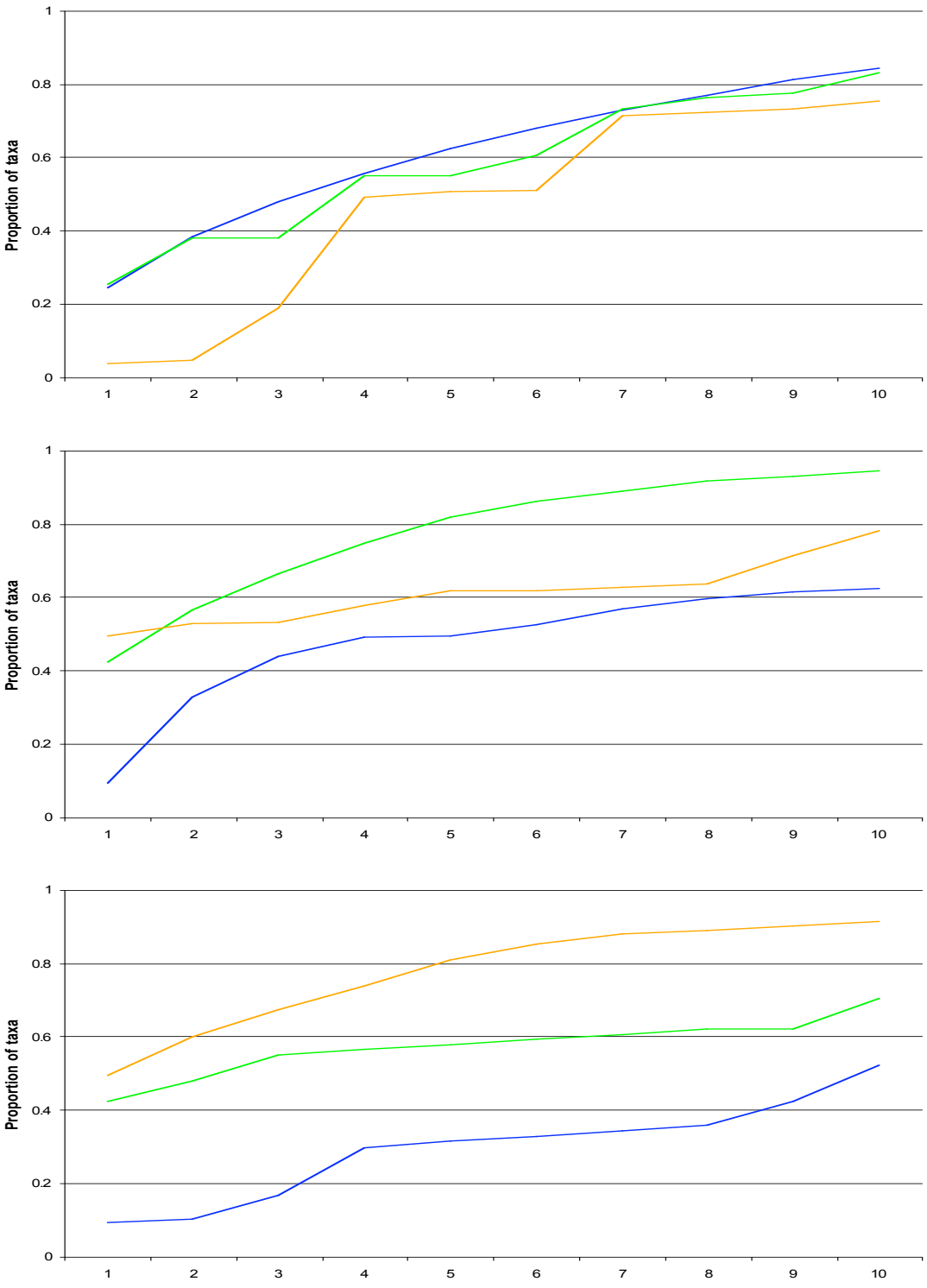


Figure 2. Cumulative proportion of taxa for the first ten site sequences selected using the iterative technique using: vascular plants (top), mosses (middle) and macrofungi (bottom. Vascular plants = blue, mosses = green and macrofungi = orange.

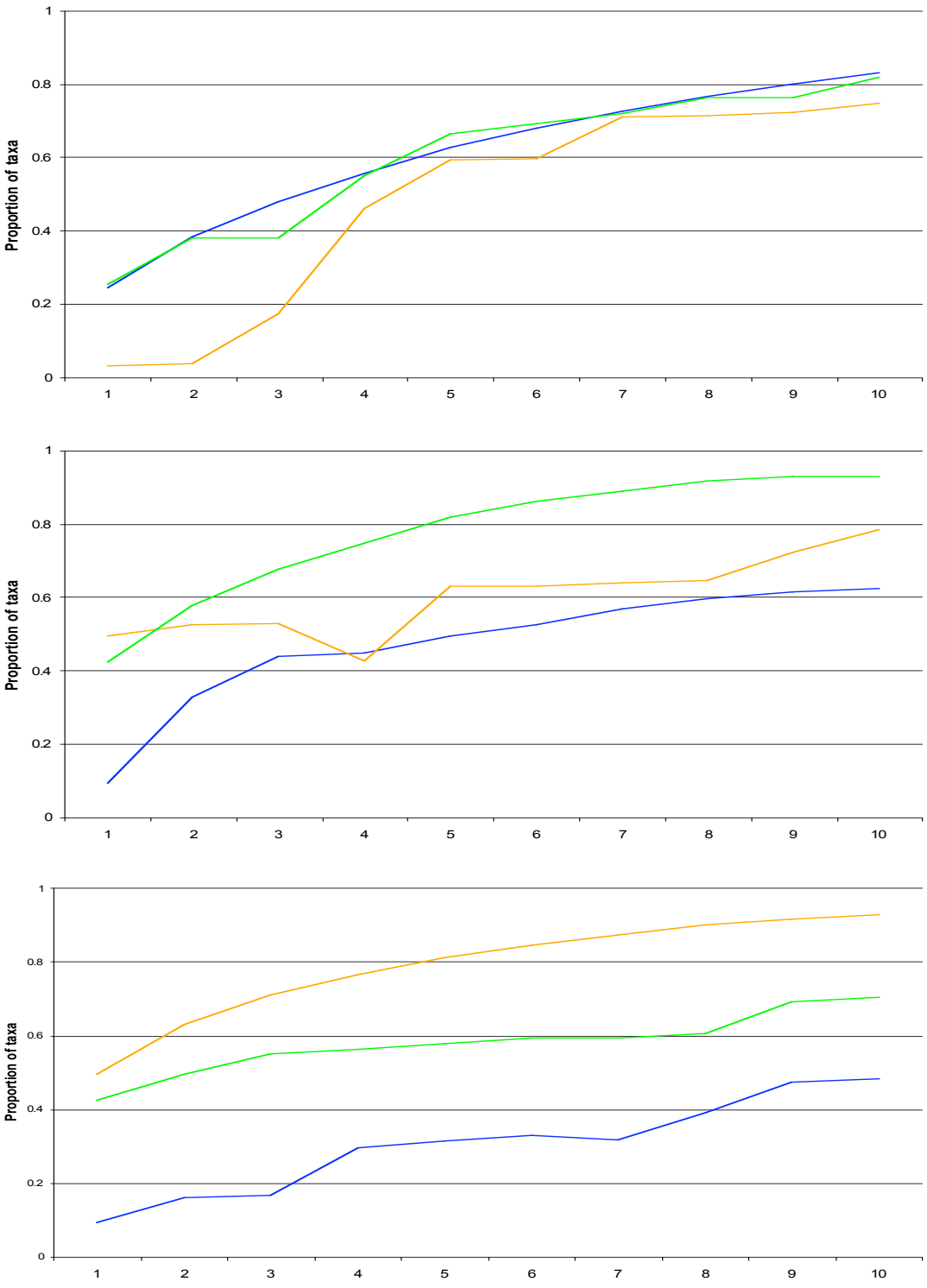


Figure 3. Cumulative proportion of taxa for the first ten sites selected by the optimisation algorithm for the (top) vascular plants, (middle) mosses and (bottom) macrofungi data sets. Vascular plants = blue, mosses = green and macrofungi = orange.

Site selections made randomly-by-vegetation-type reserved more taxa across the three biotic groups after six sites (>50%) were reserved than did the fully random site selection (Figure 4). The 95% confidence intervals were slightly broader for the random site selections than for the random by vegetation type site selections. The random by vegetation type site selections show periodic changes in slope, particularly for the macrofungi and mosses. This arises from some vegetation types consistently adding proportionally fewer taxa than other vegetation types. For example, for the macrofungi every wet forest site that is added contributes more taxa than if an alpine heath or grassy woodland site is added.

Once again use of the iterative and optimisation site selection techniques produced nearly identical results (Table 3). Again each group gave the highest reservation levels of its own group. The vascular plant data set is the better predictor across the three biotic groups, than when either the mosses or macrofungi data sets are used. At the low reservation target of 3 sites (~10%) the proportion of taxa reserved are variable depending on the data set used for selection, with the 'all taxa' data set most evenly reserving taxa across the three biotic groups (Table 6). The iterative and optimisation site selection techniques appear to select more taxa than random site selection. Randomisation by vegetation type selects fewer species than the taxonomic groups, but selects more evenly between the taxonomic groups.

When ten sites (~30%) were targeted for reservation the use of the 'all taxa' and 'named species' only data sets selected nearly 80% of each of the three taxonomic groups, while use of 'woody plants' only selected 60-79% of the three taxonomic groups (Figure 5 & Table 6). Vascular plant data using either technique selected 75% or more of the three taxonomic groups. Sites selected by random stratified for vegetation type reserved 72-75% of taxa for the three taxonomic groups.

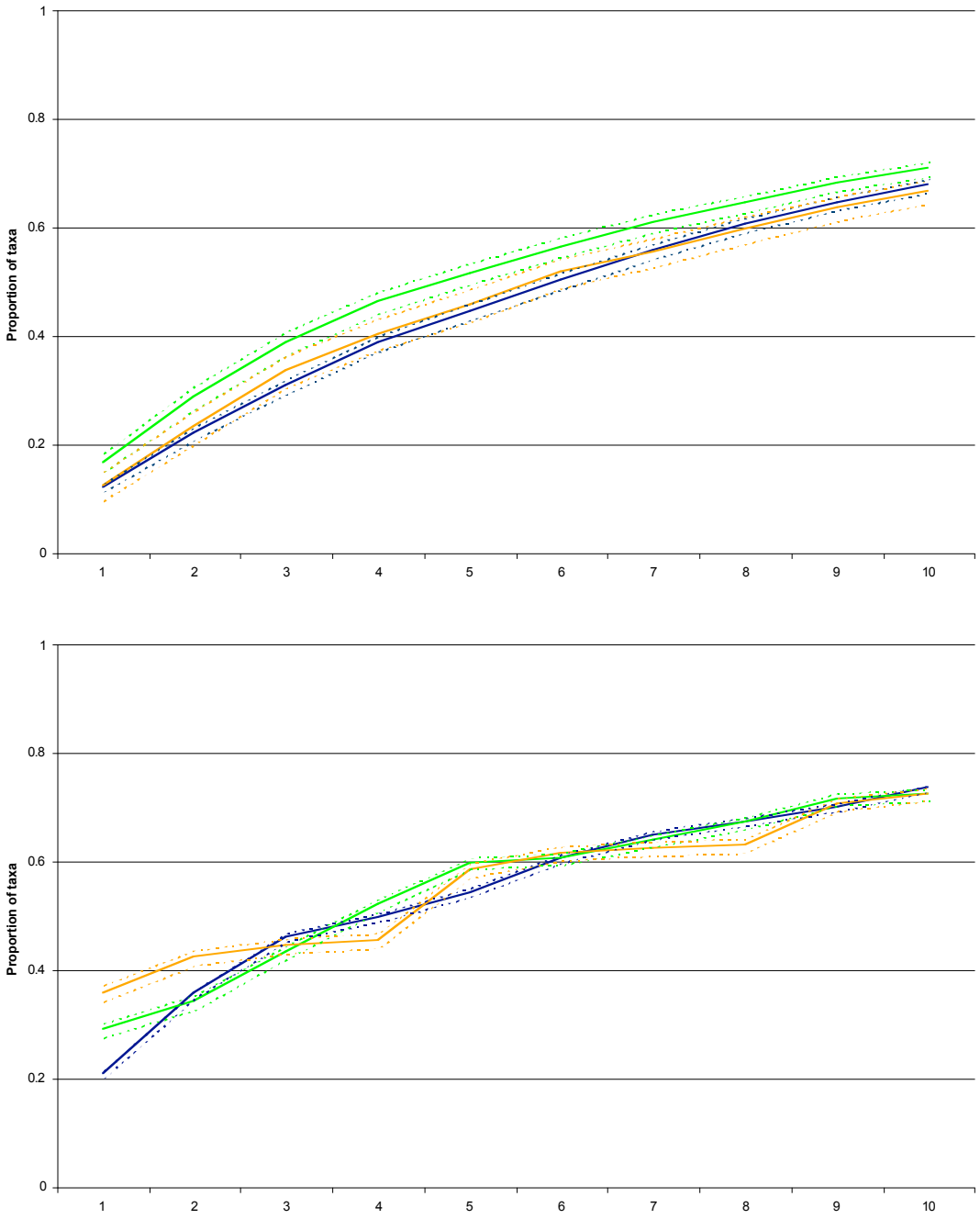


Figure 4. Cumulative proportion of taxa based on 100 site sequence selections by the random (top) and random by vegetation type (bottom). Vascular plants = blue, mosses = green and macrofungi = orange. Dashed lines are the 95% confidence limits.

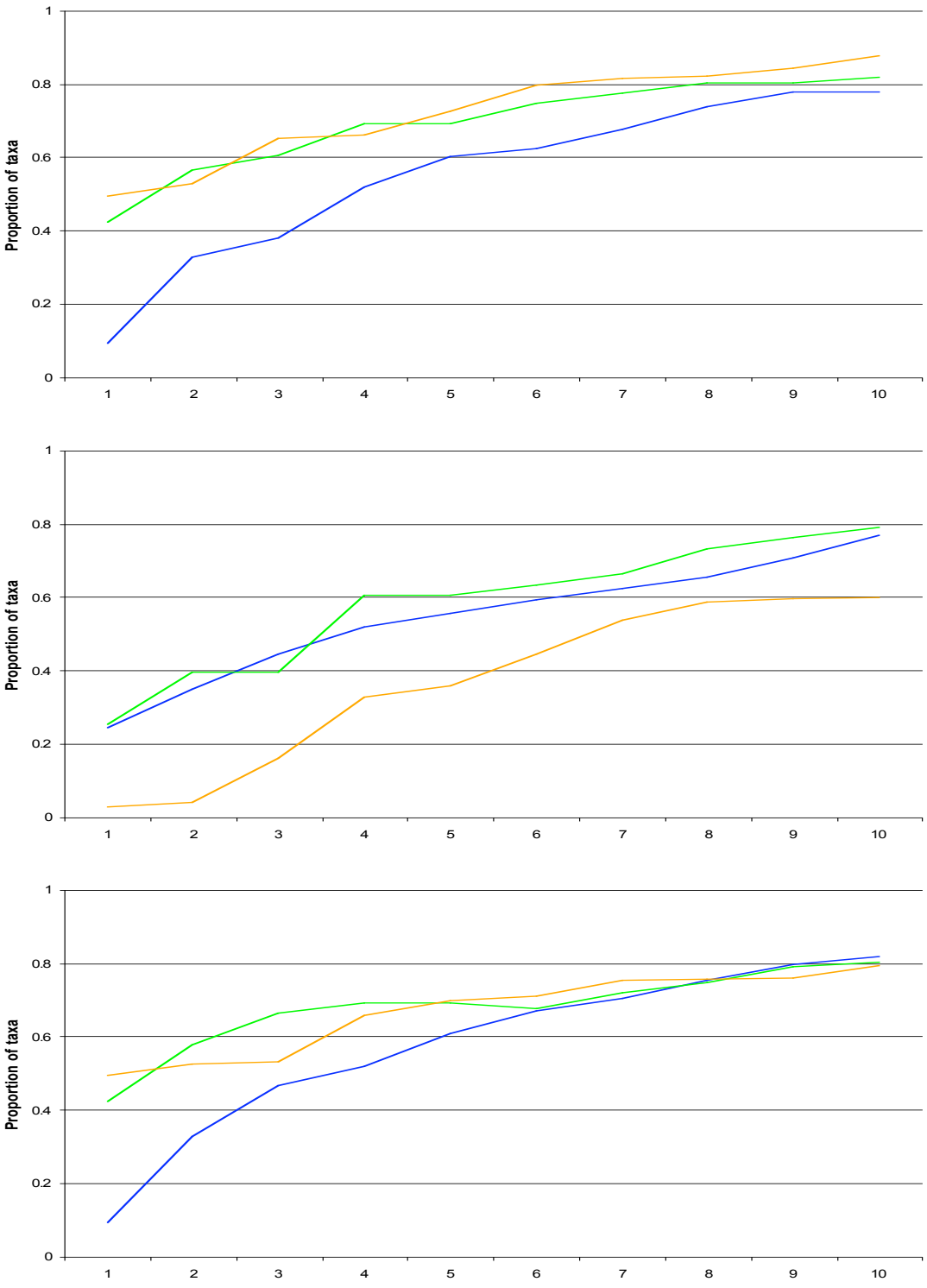


Figure 5. Cumulative proportion of taxa for the first ten sites selected by the optimisation algorithm using all taxa (top), woody plants (middle) and all named species (bottom) data sets. Vascular plants = blue, mosses = green and macrofungi = orange.

Table 6. Summary of proportion (%) of vascular plants, mosses and macrofungi reserved when 3 sites (~10%) and 10 sites (~30%) are reserved using different reserve set selection techniques. P = vascular plants, M = mosses and F = macrofungi. Fully random and random by vegetation type include 95% confidence intervals.

Reserve set selection technique	3 sites			10 sites		
	P	M	F	P	M	F
Fully Random	31 ± 1.3	39 ± 2.2	34 ± 2.9	68 ± 1.2	71 ± 1.4	67 ± 2.1
Random by vegetation type	46 ± 0.8	43 ± 1.2	45 ± 1.4	74 ± 0.6	72 ± 1.1	73 ± 1.2
All taxa iterative	38	61	65	78	82	88
All taxa optimisation	38	61	65	78	82	88
Vascular plants iterative	48	38	19	84	83	75
Vascular plants optimisation	48	38	17	83	82	75
Mosses iterative	44	66	53	62	94	78
Mosses optimisation	44	53	68	62	93	78
Macrofungi iterative	17	55	67	52	70	91
Macrofungi optimisation	17	55	71	48	70	93
Woody plants optimisation	44	39	16	77	79	60
All named species optimisation	46	66	49	82	80	73

When optimal site selections is limited the pair-wise comparisons of the biotic groups resulted in a third or less shared sites when three or ten sites only were selected (Table 7). When the full taxa selections for the taxonomic groups were compared, the woody plant and vascular plant sets were the closest, which is to be expected as woody plants are a subset of the vascular plants data (Table 7).The overlap with the vascular plants selections was 75% or more of sites. Overlap with the mosses and macrofungi were lower for the woody plants than for the vascular plants.

Table 7. Number of sites shared using different taxonomic groups for optimal site selection. First 3, 10 and full site selections shown for vascular plants (P), woody plants (WP) , mosses (M), macrofungi (F). Total possible shared number of sites in parentheses.

Shared sites	3 sites	10 sites	Full reservation
P-WP	2 (3)	4 (10)	17 (18 WP)
P-M	1 (3)	4 (10)	11 (14 M)
P-F	0 (3)	3 (10)	18 (21 F)
WP-M	1 (3)	3 (10)	5 (14 M)
WP-F	0 (3)	3 (10)	12 (21 F)
M-F	1 (3)	3 (10)	10 (14 M)

Discussion

The sites selected for complete reservation of the taxonomic groups are almost identical for the iterative and optimisation algorithms. This occurs as a result of the high number of sites with irreplaceable taxa (singletons) for the different groups. Once sites containing singleton taxa are reserved all or most other taxa from that group are also reserved. This is consistent with the results of Pressey (1999) who showed that, where there are many sites with rare taxa, heuristic algorithms select similar sites to optimisation algorithms. The high number of sites with singleton taxa in all taxonomic groups means that if the conservation goal is to conserve all taxa, then many sites need to be reserved.

When fewer sites are chosen for reservation the differences between the different selection criteria are more pronounced. Where numbers of sites to be selected are restricted to three (~10%) sites, the selection using vascular plants gives poor results for the reservation of cryptogamic groups, particularly the macrofungi. This suggests that at low levels of land reservation, vascular plant representation may not represent cryptogams. Where higher proportions of sites are selected using vascular plants, reservation of the common moss and macrofungal taxa will occur, as is apparent in the ~30% and full reservation analyses.

Selection using data from a single taxonomic group reduces the relative proportion of taxa reserved in the other taxonomic groups. This is in keeping with other studies where site selections based on one group do not maximise the selection of taxa in other groups. For forest in Tuscany when plots were chosen to maximise vascular plant richness, important sites for the reservation of bryophytes and macrofungi were missed (Chiarucci *et al.* 2005; Chiarucci *et al.* 2007). Species richness in one group rarely correlates well with that of other groups at the site level (Lindenmayer *et al.* 2002; Roberge & Angelstam 2004; Orme *et al.* 2005).

Given the dominance of vascular plants and woody plants data in planning for conservation in Tasmania, it is reassuring that, when choosing about one third of the sites (ten) from the optimisation using vascular plants, 80% of the vascular plants and mosses and 73% of the macrofungi were also reserved. Similarly, if the 26 sites that are needed to reserve vascular plants once were reserved, this selection of sites would also reserve 97% of both the moss and macrofungal taxa.

Given the cost of complete biodiversity studies, managers are unlikely to have the luxury of such data sets on which to base their decisions (Magurran 2004). It is interesting that site sequences based on selection using random-by-vegetation-type produced unbiased reservation across the three groups. This may be because vegetation type reflects both variation in species composition and environmental variation. Many authors suggest that using a combination of species and environmental data will allow for better outcomes in conservation planning than will either in isolation (Kirkpatrick & Brown 1994; Faith and Walker 1996; Faith & Walker 2002; Brooks *et al.* 2004; Cowling *et al.* 2004; Faith *et al.* 2004; Pressey 2004). The only reservation methods that were better across all groups than the stratified random by vegetation type were the site selections made using 'all taxa', 'all named species' or 'vascular plant' data distributions. Where data are available for all groups, use of the named species may have a better chance of reserving important sites for all groups.

The proportion of singletons across the three taxonomic groups was approximately 25%, this is the same proportion as angiosperms in the Neotropics (Koopowitz *et al.* 1994). Factors which drive the distributions of rare species are often complex and are often unknown for poorly studied organisms like cryptogams (Gaston & Rodrigues 2003; Magurran 2004; Cleavitt 2005; Molina *et al.* 2006). Factors which affect cryptogam distribution, particularly for the macrofungi, are poorly understood in Australia. On the one hand species of macrofungi seem to be more widespread and with fewer regional endemics in comparison to vascular plants (May 2002). Yet Schmit *et al.* (2005) and Mueller *et al.* (2007)

surmise that at the continental scale the proportions of vascular plants and macrofungal endemism are similar. All nine wet forest sites in the present study included singleton macrofungal taxa, requiring all nine wet forest sites to be reserved for complete reservation of the macrofungi. Interestingly, wet forest is the vegetation type in the present study in which macrofungal taxon richness is the highest, yet vascular plant taxon richness is low.

Conservation decisions would be best if made using sound knowledge of species distribution for all target taxa. Where such data are not available, named species for all groups may be the best surrogate. However, considerable effort is required to identify to species level in some macrofungi and in some moss groups. Given the limited resources and expertise likely to be available for including cryptogams in surveys, it would be worth exploring subsets of moss and macrofungal taxa that could be more readily identified to species, in order to utilise the predictive power of named species, rather than attempting the very time consuming task of identification of all species. Where no data on the cryptogamic groups are available, vascular plant data or a stratified reserve selection based on vegetation type are likely to be reasonable surrogates. Nevertheless, the reasonable predictive power of plant data needs to be confirmed at spatial scales larger than those of the current study. Also a wider variety of locations need to be examine to determine the consistency of this pattern.

References

Andelman S, Fagan WF (2000) Umbrellas and flagships: Efficient conservation surrogates or expensive mistakes? *Proceedings of the National Academy of Sciences of the United States of America* **97**, 5957-5959.

Belbin L (2003a) PATN: Pattern Analysis Package. In Pattern analysis program. (Blatant Fabrications: Bonnet Hill, Tasmania)

Belbin L (2003b) PATN: Pattern Analysis Package: Technical Reference. In. (Blatant Fabrications: Bonnet Hill, Tasmania)

Brooks T, Da Fonseca GAB, Rodrigues ASL (2004) Species, data, and conservation planning. *Conservation Biology* **18**, 1682-1688.

Brown MJ, Jarman SJ, Kantvilas G (1994) Conservation and reservation of nonvascular plants in Tasmania, with special reference to lichens. *Biodiversity and Conservation* **3**, 263-278.

Buchanan PK, May TW (2003) Conservation of New Zealand and Australian fungi. *New Zealand Journal of Botany* **41**, 407-421.

Caro TM, O'Doherty G (1999) On the use of surrogate species in conservation biology. *Conservation Biology* **13**, 805-814.

Convention on Biological Diversity (2007) Convention on Biological Diversity. In 'Convention on Biological Diversity'. (United Nations Environment Programme)

Chiarucci A, D'Auria F, De Dominicis V, Lagana A, Perini C, Salerni E (2005) Using vascular plants as a surrogate taxon to maximise fungal species richness in reserve design. *Conservation Biology* **19**, 1644-1652.

Chiarucci A, D'auria F, Bonini I (2007) Is vascular plant species diversity a predictor of bryophyte species diversity in Mediterranean forests? *Biodiversity and Conservation* **16**, 525-545.

Cleavitt NL (2005) Patterns, hypotheses and processes in the biology of rare bryophytes. *The Bryologist* **108**, 554-566.

Cowling RM, Knight AT, Faith DP, Ferrier S, Lombard AT, Driver A, Rouget M, Maze K, Desmet PG (2004) Nature conservation requires more than a passion for species. *Conservation Biology* **18**, 1674-1679.

Environment Australia. (2001) 'National Objectives and Targets for Biodiversity Conservation 2001-2005.' (Department of the Environment and Heritage, Environment Australia, Canberra.

Faith DP, Ferrier S, Walker PA (2004) The ED strategy: how species level surrogates indicate general biodiversity patterns through and 'environmental diversity' perspective. *Journal of Biogeography* **31**, 1207-1217.

Faith DP, Walker PA (1996) Environmental diversity: on the best possible use of surrogate data for assessing the relative biodiversity of sets of areas. *Biodiversity and Conservation* **5**, 399-415.

Faith DP, Walker PA (2002) The role of trade-offs in biodiversity conservation planning: linking local management, regional planning and global conservation efforts. *Journal of Biosciences* **27**, 393-407.

Favreau JM, Drew CA, Hess GR, Rubino MJ, Koch FH, Eschelbach KA (2006) Recommendations for assessing the effectivenesss of surrogate species approaches. *Biodiversity and Conservation* **15**, 3949-3969.

Gaston KJ, Rodrigues ASL (2003) Reserve selection in regions with poor biological data. *Conservation Biology* **17**, 188-195.

Hallingback T (2007) Working with Swedish cryptogam conservation. *Biological Conservation* **135**, 334-340.

Hallingback T, Hodgetts N (2000) 'Mosses, Liverworts, and Hornworts.' IUCN/SSC Bryophyte Specialist Group, Gland, Switzerland and Cambridge, UK.

Hawksworth DL (1995) 'Biodiversity: Measurement and Estimation.' Royal Society London (Series B. Biological Sciences) (Chapman & Hall: London)

Hawksworth DL (1997) Orphans in 'Botanical' diversity. *Muelleria* **10**, 111-123.

Hylander K (2007) The conservation ecology of cryptogams. *Biological Conservation* **135**, 311-314.

International Union for Conservation of Nature Species Survival Commission (2007) Fungi Specialist Group Website. In 'The World Conservation Union and Species Survival Commission'. pp. http://www.rbg.vic.gov.au/iucnsscfungi/welcome_to_iucn. (Fungi Specialist Group)

Kirkpatrick JB (1983) An iterative method for establishing priorities for the selection of nature reserves: an example from Tasmania. *Biological Conservation* **25**, 43-57.

Kirkpatrick JB (1990) A synusia-based mapping system for the conservation management of natural vegetation, with an example from Tasmania, Australia. *Biological Conservation* **53**, 93-104.

Kirkpatrick, J. B. 1998. Nature conservation and the regional forest agreement process. Australian Journal of Environmental Management **5**:31-37.

Kirkpatrick JB (1999) 'Developing and applying criteria for forest protected areas - the Australian experience.' Commonwealth of Australia, Canberra.

Kirkpatrick JB, Barker P, Brown MJ, Harris S, Mackie R (1995) 'The reservation status of Tasmanian vascular plant communities.' Parks and Wildlife Service, Tasmania, Hobart.

Kirkpatrick JB, Brown MJ (1994) A comparison of direct and environmental domain approaches to planning reservation of forest higher plant communities and species in Tasmania. *Conservation Biology* **8**, 217-224.

Kirkpatrick JB, Gilfedder L, Duncan F, Harris S (1991a) Reservation status and priorities for Tasmanian plants I. Angiospermae (Dicotyledonae). In 'Aspects of Tasmanian Botany: A Tribute to Winifred Curtis'. (Ed. SJS M.R. Banks, A.E. Orchard and G. Kantvials) pp. 163-172. (Royal Society of Tasmania: Hobart, Tasmania)

Kirkpatrick JB, Gilfedder L, Hickie J, Harris S (1991b) 'Reservation and conservation status of Tasmanian native higher plants.' Wildlife Division, Department of Parks, Wildlife and Heritage, Tasmania, 91/2, Hobart, Tasmania.

Kirkpatrick JB, Jensen A, Bridle KL (2007) 'The future of the run country.' In People, Sheep and Nature Conservation - the Tasmanian Experience. (CSIRO Press: Collingwood, Victoria)

Kirkpatrick JB, McDonald M, Mendel L, Dyring J, Lynch AJJ, Johnson K (1997) 'Identification of habitats of rare and threatened plant species and communities in Tasmania.' Tasmanian Conservation Trust, Hobart, Tasmania.

Koopowitz H, Thornhill AD, Andersen M (1994) A general stochastic model for the prediction of biodiversity losses based on habitat conversion. *Conservation Biology* **8** 425–438.

Lamoreux JF, Morrison JC, Ricketts TH, Olson DM, Dinerstein E, McKnight MW, Shugart HH (2006) Global tests of biodiversity concordance and the importance of endemism. *Nature* **440**, 212-214.

Lindenmayer DB, Cunningham RB, Donnelly CF, Lesslie R (2002) On the use of landscapes surrogates as ecological indicators in fragmented forests. *Forest Ecology and Management* **159**, 203-216.

Magurran AE (2004) 'Measuring Biological Diversity.' (Blackwell Publishing: Carlton)

Margules CR, Nicholls AO, Pressey RL (1988) Selecting networks of reserves to maximise biological diversity. *Biological Conservation* **43**, 63-76.

Margules CR, Pressey RL (2000) Systematic conservation planning. *Nature* **405**, 243-253.

May TW (2002) Where are the short-range endemics among Western Australian macrofungi? *Australian Systematic Botany* **15**, 501-511.

May TW (2003) Conservation of Australian fungi - knowledge is the key. In 'Plant Conservation - Approaches and Techniques From An Australian Perspective'. (Eds CL Brown, F Hall and J Mill) pp. 1-16. (Australian Network for Plant Conservation: Australia)

Mendel L, Kirkpatrick JB (2002) Historical progress of biodiversity conservation in the protected-area system of Tasmania, Australia. *Conservation Biology* **16**, 1520-1529.

Molina R, Marcot BG, Lesher R (2006) Protecting rare, old-growth, forest-associated species under the survey and manage program guidelines of the Northwest Forest Plan. *Conservation Biology* **20**, 306–318.

Moore D, Nauta M, Evans SE, Rotheroe M (2001) 'Fungal Conservation - Issues and Solutions.' Special Volume of the British Mycological Society (Cambridge University Press and British Mycological Society: Cambridge, UK)

Moscal A, Askey-Doran MJ, Kirkpatrick JB, Lambourne MJ, Dalton PJ, Seppelt R (1997) A preliminary assessment of the conservation and reservation status of Tasmanian bryophytes.

Moscal A, Kirkpatrick JB (1992) 'The conservation status of Tasmanian species of hepatics and bryophytes.' Tasmanian Conservation Trust, Hobart, Tasmania.

Mueller GM, Schmit JP (2007) Fungal biodiversity: what do we know? What can we predict? . *Biodiversity and Conservation* **16**, 1-5.

Mueller GM, Schmit JP, Leacock PR, Buyck B, Cifuentes Jn, Desjardin DE, Halling RE, Hjortstam K, Iturriaga T, Larsson K-H, Lodge DJ, May TW, Minter D, Rajchenberg M, Redhead SA, Ryvarden L, Trappe JM, Watling R, Wu Q (2007) Global diversity and distribution of macrofungi. *Biodiversity and Conservation* **16**, 37-48.

Natural Resource Management (2007) Natural Resource Management: http://www.nrm.gov.au/index.html. (Australian Government)

Norden B, Paltto H, Gotmark F, Wallin K (2007) Indicators of biodiversity, what do they indicate? - Lessons for conservation of cryptogams in oak-rich forest. *Biological Conservation* **135**, 369-379.

Orme CDL, Davies RG, Burgess M, Eigenbrod F, Pickup N, Olson VA, Webster AJ, Ding T-S, Rasmussen PC, Ridgely RS, Stattersfield AJ, Bennett PM, Blackburn TM, Gaston KJ, Owens IPF (2005) Global hotspots of species richness are not congruent with endemism or threat. *Nature* **436**, 1016-1019.

Poiani KA, Merrill MD, Chapman KA (2001) Identifying conservation-priority areas in a fragmented Minnesota landscape based on the umbrella species concept and selection of large patches of natural vegetation. *Conservation Biology* **15**, 513-522.

Pressey RL (1999) Effects of data characteristics on the results of reserve selection algorithms. *Journal of Biogeography* **26**, 179-191.

Pressey RL (2002) Classics in physical geography revisited. *Progress in Physical Geography* **26**, 434-441.

Pressey RL (2004) Conservation planning and biodiversity: assembling the best data for the job. *Conservation Biology* **18**, 1677-1681.

Pressey RL, Possingham HP, Margules CR (1996) Optimality in reserve selection algorithms: When does it matter and how much? *Biological Conservation* **76**, 259-267.

Roberge J, Angelstam P (2004) Usefulness of the umbrella species concept as a conservation tool. *Conservation Biology* **18**, 76-85.

Saetersdal M, Gjerde I, Blom HH (2005) Indicator species and the problem of spatial inconsistency in nestedness patterns. *Biological Conservation* **122**, 305-316.

Sarkar S, Pressey RL, Faith DP, Margules CR, Fuller T, Stoms DM, Moffett A, Wilson KA, Williams KJ, Williams PH, Andelman S (2006) Biodiversity conservation planning tools: present status and challenges for the future. *Annual Review of Environment and Resources* **31**, 123-159.

Schmit JP, Mueller G, Leacock PR, Mata JL, Wu Q, Huang Y (2005) Assessment of tree species richness as a surrogate for macrofungal species richness. *Biological Conservation* **121**, 99-110.

Shafer CL (1990) 'Nature Reserves : Island Theory and Conservation Practice ' (Smithsonian Institution Press Washington, DC)

Solomon M, Van Jaarsveld AS, Biggs HC, Knight MH (2003) Conservation targets for viable species assemblages? . *Biodiversity and Conservation* **12**, 2435-2441.

Soule ME, Sanjayan MA (1998) Conservation Targets: Do they help? *Science* **279**, 2060-2061.

Stewart RR, Ball IR, Possingham HP (2007) The effect of incremental reserve design and changing reservation goals on the long-term efficiency of reserve systems. *Conservation Biology* **21**, 346-354.

Turner D (2007) Optimisation Script. School of Geography and Environmental Studies: Hobart.

United Nations Environment Programme (2004) Indicators for assessing progress towards the 2010 Target: Coverage of protected areas. In. (Ed. Subsidiary Body On Scientific Technical And Technological Advice) http://www.cbd.int/2010-target/documents.shtml. (United Nations Environment Programme, Convention on Biological Diversity)

Wilson KA, McBride MF, Bode M, Possingham HP (2005) Prioritizing global conservation efforts. *Nature* **440**, 337-340.

Chapter 8 - Implications for the Conservation of Cryptogams

Introduction

Rarely do conservation planners and land managers specifically consider the requirements of cryptogams. The organisms typically included are vertebrates and vascular plants, as well as taxa recognised as rare taxa. There also often is consideration of vegetation types, particularly rare communities. Cryptogams have received limited specific legislated conservation effort to date. This is in part due to the problems of applying IUCN-like threat categories, such as those discussed for bryophytes by (Hallingback 2007). These problems included uncertainty about defining genetic individuals, the lack of distributional data and limited understanding of how threatening processes affect cryptogams.

The paucity of data on cryptogams exacerbates the limited consideration by planners and managers, creating a postive feedback: little is known about cryptogams so they are not seen as a priority for research. Even when data on cryptogams are collected there is often no wider context available for its general interpretation. Given limited time and funding and in the absence of data, most conservation planners and land managers work with the assumption that, if easily identifiable elements of ecosystems are adequately conserved and managed, then the cryptogams in these ecosystems also will be adequately protected.

The present study was initiated to test the validity of the assumption that data on other taxa, vegetation and environmental conditions can act as surrogates for cryptogams. A set of easily obtainable environmental data (including substrate cover) was collected along with information on the occurrence of vascular plants, mosses and macrofungi. Of these data sets, canopy cover and substrate (among the environmental variables) and vegetation type and woody vascular plants (among the biotic data) were the quickest and easiest to obtain. These data sets are considered

typical of those used for real world conservation planning. They were tested to determine their usefulness as surrogates for mosses and macrofungi, the data for which were collected from the same sites.

Surrogates for cryptogam conservation

The supposition that if vegetation types are adequately conserved most cryptogams within these vegetation types will also be conserved is supported by the results presented in Chapters 3, 4 and 6. Vegetation type, at the broad floristic formation level, reflects both the distributions of the biotic groups in this study (vascular plants, mosses and macrofungi) and the range of environmental variables. Canopy cover, type of geology and altitude were the environmental factors which had the strongest associations with vegetation type. Substrate cover distribution patterns are also a reflection of vegetation type. The strong correlations between the vascular plants and the mosses and macrofungi are evidence that vascular plants would also be a good surrogate for the cryptogams. This conclusion was also reached for lowland forest in Central New South Wales (Pharo *et al.* 1999; Pharo & Beattie 2001), which is the only other Australian study to have tested congruence between vascular plants and cryptogams.

Although there was good congruence at the formation level for biotic groups, singletons and less common taxa had low concordance between biotic groups resulting in very different early sequences of site selection for reservation. When the numbers of sites selected for reservation were restricted (to about 10% of total sites), the biotic groups were poor surrogates for each other. The data do not allow much to be said about the rarer taxa beyond their uncommon occurrences. Other authors have also concluded that low reservation targets (5-15%) are inadequate for effective biodiversity conservation (Solomon *et al.* 2003; Gjerde *et al.* 2004).

For common taxa, the adequacy of both vegetation type and vascular plant data as surrogates for mosses and macrofungi is supported by

reservation scenarios in which nearly all the common taxa (the approximately 75% of taxa which are not singletons) are selected when 30% of sites are selected for reservation, using either vascular plant data or equal proportions of each vegetation type selected at random. Similarly, Pharo *et al.* (2000) found in forests in Central New South Wales that most common bryophytes and lichens were included when overstorey plants were used for site selection.

Vascular plants and vegetation types may be useful surrogates at broader spatial scales, but further testing is needed to check that the correlations found in the present study, which were at a local spatial scale (ten square kilometres), between vegetation types and biotic groups is consistent at bioregional scales. Also it should be tested to see if vascular plants can also be used as surrogates for cryptogams within vegetation types or plant communities. For example, the variation found in Tasmanian ant distributions were predicted by the wet/dry delimitations of vegetation formation rather than being concordant with specific vegetation types (Meeson 2006). Similarly, Tasmanian carabid beetle distributions were not fully represented when vegetation attributes alone were used to select sites for reservation (Michaels & Mendel 1998). Within vegetation-type variation may be related to subtle variation in site characteristics or to succession (see below).

Associations with substrate

Many cryptogams have specific associations with substrate (McAlister 1997; Bates 2000; Cleavitt 2001; Turner & Pharo 2005; Lohmus *et al.* 2007). Substrate preferences of the macrofungi investigated in this present study were an expression of trophic mode, with ectomycorrhizal fungi generally being terrestrial, and saprotrophic fungi most often occurring on dead organic matter. However, within the saprotrophic fungi there was some variation in substrate preference. There were a few macrofungi generalists that utilised any woody substrate but many of the saprotrophic fungi showed a clear preference for particular woody substrates such as woody litter, smaller wood or larger wood. Most of the

macrofungi considered in this study exhibited consistent substrate preferences across different vegetation types. Within wet forest sites most mosses were found on all substrates, although most species still showed a preference for particular substrates. Mosses had more restricted distributions on substrates in the heathy woodland, grassy woodland and alpine heath sites. Most species on these sites were found on soil or rock.

The strong substrate associations of the mosses and macrofungi found in this present study are particularly important in the light of the research in Fenno-Scandinavia into red-list species distribution and the related importance of old growth forest characteristics (Berg *et al.* 1994; Jonsson *et al.* 1999; Heilmann-Clausen & Christensen 2003; Jonsson *et al.* 2005; Odor *et al.* 2006). One of the reasons that older forests contain more red-listed species is because there is proportionally more woody substrate (Jonsson & Kruys 2001; Lohmus *et al.* 2007; Rudophi *et al.* 2007). Also, large woody substrate is more common in natural and semi-natural forests than in managed forests (Desponts *et al.* 2002; Franklin *et al.* 2002; Humphrey *et al.* 2002). When corrections for amounts of available substrate were made between young and older managed Scandinavian forests, the proportion of red-listed (see note above) species are the same (Rudophi *et al.* 2007). This new work implies that the amount of available substrate may be more important than the 'old growth' qualities of many sites with red listed species. Either way many authors suggest that management which retains larger woody substrates and diversity of substrates generally is likely to improve conservation outcomes for cryptogams and biodiversity (Hansen *et al.* 1991; Qian *et al.* 1999; Ough 2001; Siitonen 2001; Yee *et al.* 2001; Lindenmayer & McCarthy 2002; Jonsson *et al.* 2005; Lohmus *et al.* 2007).

Moist, shaded wet forest sites had higher moss and macrofungal species richness than open sites, or dry shaded sites or moist unshaded sites (Chapters 4 & 5). The strong correlation ($r = 0.83$) in wet forest and heathy woodland between mosses and macrofungi, and between mosses and saprotrophic macrofungi, may well be due to these cryptogamic

groups having similarly strong responses to microclimate. Microhabitat specificity, as demonstrated in Chapter 5, has been found in many studies on bryophytes (Vellak & Paal 1999; Mills & Macdonald 2004; Jansova & Soldan 2006). Newmaster *et al.* (2005) highlighted the need to identify and then conserve specific microhabitats of high conservation value for cryptogams (such as cliffs or long undisturbed sites) at a landscape scale, in order to conserve rare bryophyte taxa that have strong substrate association which are not found in the dominant mesohabitat. There is a need to develop a system to identify and conserve key cryptogam habitats in Australia, as has been done in Europe (Gustafsson *et al.* 1999; Hallingback 2007; Natura 2000 2007).

Preferences for substrates, and/or microclimates or microhabitats are driven by the basic biology of the different groups of cryptogams. An alternative to managing individual species of cryptogam separately would be to group cryptogams according to their seral stage, functional group, microclimate or substrate preferences. A hierarchical structure of species could be developed that would allow for the management of species with different trophic modes. For example, one group would be for species which favour large old wood, which is a substrate that is common in old growth forests (>110 years old and unlogged). Species which have associations with large old wood could then be further considered under functional subcategories, such as photosynthetic species (mosses, lichens and algae) and saprotrophic/decomposer species (invertebrates, fungi and microbes). Although the specific trophic and biological preferences are not currently known for all cryptogam species, there is enough information to allow most taxa to be categorised. Lists of taxa in these categories plus working knowledge of ecosystem food-webs would facilitate better planning, monitoring and management of cryptogams, and the ecosystems in which they play a major role.

Succession and disturbance

Substrate abundances and species composition of macrofungi were related to time since fire (Chapter 5). Other researchers have also shown

that within a vegetation type or vascular plant community much of the cryptogamic variation can be explained by suites of taxa which favour seral stages and or substrates common at particular seral stages (Söderström 1989; Crites & Dale 1998; Rambo & Muir 1998; McMullan-Fisher *et al.* 2002; Robinson & Bougher 2003; Turner & Pharo 2005; Botting & Fredeen 2006; Lohmus *et al.* 2007). Further work into the distribution patterns of cryptogams at bioregional scales and their substrates associations across the seral stages of Australian vegetation will be important in guiding planning and management decisions.

The results of Chapter 5 reinforce a generally recognised need for representation within conservation reserves of all stages of succession (Pickett & White 1985). This is a need that is particularly pressing for the cryptogams, some of which are not present at all seral stages, or necessarily occur in vegetation of similar age subjected to different disturbance regimes. For example, in Tasmanian mixed forest most vascular plants other than the epiphytic ferns and rainforest elements were present in 20-30 year old forests (Hickey 1994). This contrasts with the bryophytes of these mixed forests, many of which are limited to older forests (Turner 2003). Given that for some cryptogams substrate and microclimate preferences explain their distributions better than vegetation type, an understanding of the causes of variation in substrate distribution is also important. These can be strongly linked to successional stage, as in the example of the Discomycete sp. A, which was associated with *Orites acicularis* litter (*O. acicularis* only being prominent in alpine vegetation in the later stages of succession after fire (Kirkpatrick *et al.* 2002)). In addition, old growth forests per se have characteristics which particularly favour some cryptogam species, like large, moist logs which are undisturbed for long periods of time. Many of these old growth forest specialist species are rare in the modern landscape due to large scale disturbances like clearing. The link between some rare cryptogam species and forests with old growth characteristics has been found by many researchers across the world (Söderström 1988; Berg *et al.* 1994; Jonsson *et al.* 1999; Vellak & Paal 1999; Heilmann-Clausen & Christensen 2003; Jonsson *et al.* 2005; Odor *et al.* 2006).

Given the associations between substrate and microhabitat it follows that disturbance and modification of vegetation will potentially affect mosses and macrofungi. Canopy changes can be monitored, either at specific sites or remotely using remote sensing techniques (Sader *et al.* 2001; Hoch *et al.* 2002). Canopies are easily opened by fire, drought, tree thinning, or introduction of tracks and roads. Opening up of the vegetation canopy will increase available light and is likely to dry out the understorey. This is likely to decrease the species richness of mosses (Pharo *et al.* 2005; Zartman & Shaw 2006), although some mosses which prefer lighter, more open conditions, and other cryptogams, like lichens, may replace some of this lost diversity (Pharo & Beattie 1997; Vanderpoorten & Engels 2002; Pharo *et al.* 2005). It is harder to demonstrate the effects of modifications such as drier conditions on macrofungal diversity, as sporophore production is ephemeral. (DNA probing studies would be appropriate to investigate this question (Horton & Bruns 2001; Midgley *et al.* 2007).) It seems likely that drier conditions would cause the frequency of sporophore production of species that prefer wet conditions to decrease, probably being limited to periods of high rainfall (O'Dell *et al.* 1999; Mueller *et al.* 2004).

Conservation of rare cryptogams

Beyond the very few species that have been listed for protection, cryptogams have infrequently been considered for conservation management in Australia (Scott *et al.* 1997; Buchanan & May 2003). Conservation planning and management are complex processes and are often limited by time, funding and data availability. The goals, timeframe and funding usually dictate the scope of management plans. Many conservation plans, other than specific threatened species recovery plans, are based on the current available literature, rather than on extensive recent surveys. Literature on cryptogams is particularly limited in Australia, so they are also not usually specifically included in management plans. The following discussion recognises that specific

conservation goals and funding levels will dictate the possible scope of conservation plans and management.

Despite the reassuringly strong associations with surrogates like vascular plants and vegetation types, use of these surrogates has only been shown to be likely to cover the common cryptogams. The uncommon cryptogamic taxa (i.e. taxa found from a single site) made up about 25% of the diversity in this study. Working out which factors are central in causing species rarity is often difficult (Gaston 1994; Magurran 2004). It seems likely that the uncommon cryptogams may be rare because of specific requirements or limitations in their dispersal ability (Herben & Söderström 1992; Edman *et al.* 2004; Cleavitt 2005; Gibson 2005; Pharo & Zartman 2007; Söderström *et al.* 2007; Vellak *et al.* 2007; Virtanen & Oksanen 2007). It is clear from the scenarios presented in Chapter 6 that the conservation requirements of uncommon taxa will need to be specifically addressed, as these uncommon taxa are unlikely to be completely covered by a general effort for the conservation of all ecosystems.

More information is needed on the biology and ecology of uncommon species if informed planning and management of all cryptogams is to be achieved. This is not just a plea for more research for its own sake: in one of the few cases where a knowledge gap about rare taxa (Molina *et al.* 2006; Thomas *et al.* 2006; Molina 2008) has shown that there are truly rare cryptogamic taxa, not just a data deficiency. The systematic survey of taxa from late successional and old growth forests from the Pacific Northwest (USA) the subsequent analysis discriminated between truly rare taxa and previously rarely recorded taxa. Consequently the local conservation planners were able to use the findings of these surveys to directly adapt to the needs of species.

Directions for cryptogam inventory and monitoring

The general absence of knowledge regarding the distributions and ecological preferences of Australian cryptogams was highlighted by (Scott

et al. 1997). For both macrofungi and mosses, distributions are only broadly understood and knowledge of specific associations or dependencies, such as substrate requirements, are still lacking for most species. One way to fill this knowledge gap would be to compile comprehensive inventories of species for the different groups of cryptogams over a range of sites of differing vegetation and geography. Given the strong associations between the suites of cryptogams with vegetation types and substrates found in this study, inventories that include information on vegetation type, trophic modes, and (where possible) substrate associations would be highly desirable.

The current study provides reasonably comprehensive lists of taxa for four Tasmanian vegetation types. This information adds significantly to the available inventories of macrofungi from Tasmanian wet forests (Ratkowsky & Gates 2005). It also provides the first breakdown of mosses from particular vegetation types in Tasmania, as vegetation type was not included in the most recent Tasmanian moss checklist (Dalton *et al.* 1991).

Cryptogamic inventories should be compiled at bioregional and national scales, granting us the ability to detect ecological preferences at different scales. Such inventories can also feed into global biodiversity lists (Davis & Crosby 2007; Hallingback 2007) which help us to identify global priorities. Researchers like Fleishman *et al.* (2006) who are concerned with conserving ecosystem function as well as individual taxa, advocate the use of life-history and ecological understanding in conservation planning. The combination of species and ecological presence data at different spatial scales (particularly local and bioregional) would facilitate the implementation of conservation goals based on knowledge, not supposition. Systematic monitoring of cryptogams would confirm if the suppositions made in the current study about common taxa are warranted, and would allow for ongoing adaptive management.

At a national scale, a good starting point for improving current cryptogam conservation across Australia would be to investigate the effectiveness of

the current National Reserve System (Department of the Environment, Water, Heritage and the Arts 2007) for the cryptogams. Research has shown that many cryptogams are not known to occur in current reserves (Moscal & Kirkpatrick 1992; Moscal *et al.* 1997; Kantvilas 2000; Siitonen *et al.* 2002; Molina *et al.* 2006). Complementary reservation of sites with known rare cryptogams or rare substrates and/or rare microhabitats is needed (Molina 2008). The need to verify the distribution of rare taxa was highlighted by Molina *et al.* (2006), who showed that in the Pacific Northwest forests (where many areas were set aside for late succession and old growth forest conservation) about half of the rare species thought to be associated with this forest type were still only known *outside* of reserves.

Directions for future research

Difficulties in identifying cryptogams have been a major impediment to producing cryptogamic inventories, and in particular integrating cryptogams into general biotic surveys in Australia. One solution to identification problems which was successful in this present study was to not expend undue effort in the identification of the more difficult groups. This still allowed for the recording of numerous species (formally named or not), some of which were comparatively easy to identify. A major boost to the conservation of cryptogams would come from developing a subset of species that is readily recognisable and representative of taxonomy, geography and ecologically important factors such as trophic mode and substrate preference. Such a subset could be used in established environmental and conservation surveys.

Clearly, more research into cryptogam taxonomy, distribution, biology and ecology is needed. For the timely acquisition of knowledge about cryptogams it would be particularly efficient for both taxonomic and basic research into the biological requirements of species to be performed concurrently.

The findings of the present study highlight the need for more research into cryptogams generally, but there are two main ways in which the conservation outcomes for cryptogams could be improved. First, a greater understanding of distributions at different scales and the factors driving these distributions is urgently needed. Second, for the uncommon cryptogams, research is needed in order to discover the specific reasons for the rarity of some species (i.e. do they have specific requirements, dispersal limitations, or are their a combination of reasons (Herben & Söderström 1992; Cleavitt 2005)). As Hylander (2007) observes, the need for research which can be *directly applied* to current conservation needs is essential.

Summation

There is significant congruence between vascular plants, and mosses and macrofungi at formation at the local scale. Conservation of broad vegetation types in target areas (coarse scale) is likely to conserve only common mosses and macrofungi. Unfortunately at the fine scale of sites and species, uncommon mosses and macrofungi are not necessarily concordant with vascular plants. Given the strong species associations with substrate and microhabitats, selecting sites for conservation by selecting sites with important habitat for cryptogams may be an effective strategy. However, knowledge of the specific distribution and ecological requirements of cryptogams - particularly rare species - is required. Further research into rare cryptogams is especially important given that uncommon taxa were not adequately reserved where 10% conservation targets were used.

This present study shows that evidence-based recommendations for ecology and conservation of cryptogams are possible, particularly when more easily identifiable cryptogams are focused on. Use of surrogates like those covered in the present study, and a general working knowledge of the cryptogams, their trophic modes and functions in ecosystems, would improve the scope of current land management plans for long term ecosystem sustainability.

References

Bates, J. W. 2000. Mineral nutrition, substratum ecology, and pollution. Pages 248-311 in A. J. Shaw, and B. Goffinet, editors. Bryophyte Biology. Cambridge University Press, Cambridge.

Berg, A., B. Ehnstrom, L. Gustafsson, T. Hallingback, M. Jonsell, and J. Weslien. 1994. Threatened plant, animal and fungus species in Swedish forests: distribution and habitat associations. Conservation Biology **8**:718-731.

Botting, R. S., and A. L. Fredeen. 2006. Contrasting terrestrial lichen, liverwort, and moss diversity between old-growth and young second-growth forest on two soil textures in central British Columbia. Canadian Journal of Botany **84**:120–132.

Buchanan, P. K., and T. W. May. 2003. Conservation of New Zealand and Australian fungi. New Zealand Journal of Botany **41**:407-421.

Cleavitt, N. L. 2001. Disentangling moss species limitations: the role of physiologically based substrate specificity for six species occurring on substrates with varying pH and percent organic matter. The Bryologist **104**:59-68.

Cleavitt, N. L. 2005. Patterns, hypotheses and processes in the biology of rare bryophytes. The Bryologist **108**:554-566.

Crites, S., and M. R. T. Dale. 1998. Diversity and abundance of bryophytes, lichens, and fungi in relation to woody substrate and successional stage in aspen mixed-wood boreal forests. Canadian Journal of Botany **76**:641-651.

Dalton, P. J., R. D. Seppelt, and A. M. Buchanan. 1991. An annotated checklist of Tasmanian mosses. Pages 15-32 in M. R. Banks, editor. Aspects of Tasmanian botany - A tribute to Winifred Curtis. Royal Society of Tasmania, Hobart.

Davis, M., and T. Crosby. 2007. To Have And To Hold - Carbon storage by peatland ecosystems can affect global warming -for better or worse. Perspectives: Research and Creative Activities at Southern Illinois University Carbondale

Desponts, M., A. Desrochers, L. Belanger, and J. Huot. 2002. Structure of managed and ancient conifers in the Laurentian Mountains (Quebec) and diversity of non-vascular plants. Canadian Journal of Forest Research **32**:2077-2093.

Department of the Environment, Water, Heritage and the Arts. 2007. The National Reserve System. Page http://www.environment.gov.au/parks/nrs/index.html. Department of the Environment, Water, Heritage and the Arts.

Edman, M., M. Gustafsson, J. Stenlid, B. G. Jonsson, and L. Ericson. 2004. Spore deposition of wood-decaying fungi: importance of landscape composition. Ecography **27**:103-111.

Fleishman, E., R. F. Noss, and B. R. Noon. 2006. Utility and limitations of species richness metrics for conservation planning. Ecological Indictors **6**:543-553.

Franklin, J. F., T. A. Spies, R. V. Pelt, A. B. Carey, D. A. Thornburgh, D. R. Berg, D. B. Lindenmayer, M. E. Harmon, W. S. Keeton, D. C. Shaw, K. Biblea, and J. Chen. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. Forest Ecology and Management **155**:399-423.

Gaston, K. J., editor. 1994. Rarity Chapman & Hall, Melbourne.

Gibson, M. 2005. Bryophyte reproductive ecology and conservation. Australasian Plant Conservation **14**:20-21.

Gjerde, I., M. Saetersdal, J. Rolstad, H. H. Blom, and K. O. Storaunket. 2004. Fine-scale diversity and rarity hotspots in northern forests. Conservation Biology **18**:1032-1042.

Gustafsson, L., J. De Jong, and M. Noréng. 1999. Evaluation of Swedish woodland key habitats using red-listed bryophytes and lichens. Biodiversity and Conservation **8**:1101-1114.

Hallingback, T. 2007. Working with Swedish cryptogam conservation. Biological Conservation **135**:334-340.

Hansen, A. J., T. A. Spies, F. J. Swanson, and J. L. Ohmann. 1991. Conserving biodiversity in managed forests: Lessons from natural forests. BioScience **41**:382-392.

Heilmann-Clausen, J., and M. Christensen. 2003. Fungal diversity on decaying beech logs - implications for sustainable forestry. Biodiversity and Conservation **12**:953-973.

Herben, T., and L. Söderström. 1992. Which habitat parameters are most important for the persistence of a bryophyte species on patchy, temporary substrates? Biological Conservation **59**:121-126.

Hickey, J. E. 1994. A floristic comparison of vascular species in Tasmanian oldgrowth mixed forest with regeneration resulting from logging and wildfire. Australian Journal of Botany **42**:383-404.

Hoch, G. A., B. L. Brock, and J. M. Briggs. 2002. Applications of advanced technologies in studying and managing grassland landscape integrity. Pages 390-411 in J. Liu, and W. W. Taylor, editors. Integrating Landscape Ecology Into Natural Resource Management - 16. Cambridge University Press Cambridge.

Horton, T. R., and T. D. Bruns. 2001. The molecular revolution in ectomycorrhizal ecology: peeking into the black-box. Molecular Ecology **10**:1855-1871.

Humphrey, J. W., S. Davey, A. J. Peace, R. Ferris, and K. Harding. 2002. Lichens and bryophyte communities of planted and semi-natural forests in Britain: the influence of site type, stand structure and deadwood. Biological Conservation **107**:165-180.

Hylander, K. 2007. The conservation ecology of cryptogams. Biological Conservation **135**:311-314.

Jansova, I., and Z. Soldan. 2006. The habitat factors that affect the composition of bryophyte and lichen communities on fallen logs. Preslia **78**:67-86.

Jonsson, B. G., and N. Kruys 2001. Ecology of woody debris in boreal forests. Blackwell Science, Oxford.

Jonsson, B. G., N. Kruys, and T. Ranius. 2005. Ecology of species living on dead wood - lessons for dead wood management. Silva Fennica **39**:289-309.

Jonsson, L., A. Dahlberg, C. Nilsson, O. Zachrisson, and O. Karen. 1999. Ectomycorrhizal fungal communities in late-successional Swedish boreal forests, and their composition following wildfire. Molecular Ecology **8**:205-215.

Kantvilas, G. 2000. Conservation of Tasmanian lichens. Forest Snow and Landscape Research **75**:357-367.

Kirkpatrick , J. B., K. L. Bridle, and A. S. Wild. 2002. Succession after fire in alpine vegetation on Mount Wellington Tasmania. Australian Journal of Botany **50**:145-154.

Lindenmayer, D. B., and M. A. McCarthy. 2002. Congruence between natural and human forest disturbance: a case study from Australian montane ash forests Forest Ecology and Management **155**:319-335

Lohmus, A., P. Lohmus, and K. Vellak. 2007. Substratum diversity explains landscape-scale co-variation in the species-richness of bryophytes and lichens. Biological Conservation **135**:404-414.

Magurran, A. E. 2004. Measuring Biological Diversity. Blackwell Publishing, Carlton.

McAlister, S. 1997. Cryptogam communities on fallen logs in the Duke Forest, North Carolina. Journal of Vegetation Science **8**:115-124.

McMullan-Fisher, S. J. M., T. W. May, and P. J. Keane. 2002. The macrofungal community and fire in a mountain Ash forest in southern Australia. Fungal Diversity **10**:57-76.

Meeson, N. 2006. Ants, Plants and Biodiversity Surrogates in Tasmanian Eucalypt Forests. Pages 1-233. PhD Thesis, School of Geography and Environmental Studies. University of Tasmania, Hobart.

Michaels, K., and L. Mendel. 1998. Carabid beetles and vegetation associations in the Tasmanian Eastern Tiers: implications for conservation. Pacific Conservation Biology **4**:240-249.

Midgley, D. J., J. A. Saleeba, M. I. Stewart, A. E. Simpson, and P. A. McGee. 2007. Molecular diversity of soil basidiomycete communities in northern-central New South Wales, Australia Mycological Research **111**:370-378

Mills, S. E., and S. E. Macdonald. 2004. Predictors of moss and liverwort species diversity of microsites in conifer-dominated boreal forest. Journal of Vegetation Science **15**:189-198.

Molina, R. 2008. Protecting rare, little known, old-growth forest-associated fungi in the Pacific Northwest USA: A case study in fungal conservation. Mycological Research **112**:613-638.

Molina, R., B. G. Marcot, and R. Lesher. 2006. Protecting rare, old-growth, forest-associated species under the survey and manage program guidelines of the Northwest Forest Plan. Conservation Biology **20**:306–318.

Moscal, A., M. J. Askey-Doran, J. B. Kirkpatrick, M. J. Lambourne, P. J. Dalton, and R. Seppelt. 1997. A preliminary assessment of the conservation and reservation status of Tasmanian bryophytes.

Moscal, A., and J. B. Kirkpatrick. 1992. The conservation status of Tasmanian species of hepatics and bryophytes. Pages 1-40. REport to the Australian Heritage Commission. Tasmanian Conservation Trust, Hobart, Tasmania.

Mueller, G. M., G. F. Bills, and M. S. Foster 2004. Biodiversity of Fungi - Inventory and Monitoring Methods. Elsevier Academic Press, London.

Natura 2000. 2007. Natura 2000 network - Habitats Directive. Page http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm. Europa.

Newmaster, S. G., R. J. Belland, A. Arsenault, D. H. Vitt, and T. R. Stephens. 2005. The ones we left behind: comparing plot sampling and floristic habitat sampling for estimating bryophyte diversity. Diversity and Distributions **11**:57 - 72.

O'Dell, T. E., J. F. Ammirati, and E. G. Schreiner. 1999. Species richness and abundance of ectomycorrhizal basidiomycete sporocarps on a moisture gradient in the *Tsuga heterophylla* zone. Canadian Journal of Botany **77**:1699-1711.

Odor, P., J. Heilmann-Clausen, M. Christensen, E. Aude, K. W. van Dort, A. Piltaver, I. Siller, M. T. Veerkamp, R. Walleyn, T. Standovar, A. F. M. van Hees, J. Kosec, N. Matocec, H. Kraigher, and T. Grebenc. 2006. Diversity of dead wood inhabiting fungi and bryophytes in semi-natural beech forests in Europe. Biological Conservation **131**:58-71.

Ough, K. 2001. Regeneration of wet forest flora a decade after clear-felling or wildfire - is there a difference? Australian Journal of Botany **49**:645-664.

Pharo, E. J., and A. J. Beattie. 1997. Bryophyte and lichen diversity - a comparative study. Australian Journal of Ecology **22**:151-162.

Pharo, E. J., and A. J. Beattie. 2001. Management forest types as a surrogate for vascular plant, bryophyte and lichen diversity. Australian Journal of Botany **49**:23-30.

Pharo, E. J., A. J. Beattie, and D. Binns. 1999. Vascular plant diversity as a surrogate for bryophyte and lichen diversity. Conservation Biology **13**:282-292.

Pharo, E. J., A. J. Beattie, and R. L. Pressey. 2000. Effectiveness of using vascular plants to select reserves for bryophytes and lichens. Conservation Biology **96**:371-378.

Pharo, E. J., J. B. Kirkpatrick , L. Gilfedder, L. Mendel, and P. A. M. Turner. 2005. Predicting bryophyte diversity in grassland and eucalypt-dominated remnants in subhumid Tasmania. Journal of Biogeography **32**:2015-2024.

Pharo, E. J., and C. E. Zartman. 2007. Bryophytes in a changing landscape: The hierarchical effects of habitat fragmentation on ecological and evolutionary processes. Biological Conservation **135**:315-325.

Pickett, S. T. A., and P. S. White, editors. 1985. Natural disturbance and patch dynamics. Academic Press Inc., United Kingdom.

Qian, H., K. Klinka, and X. H. Song. 1999. Cryptogams on decaying wood in old-growth forests of southern coastal British Columbia. Journal of Vegetation Science **10**:883-894.

Rambo, T. R., and P. S. Muir. 1998. Bryophyte species associations with coarse woody debris and stand ages in Oregon. The Bryologist **101**:366-376.

Ratkowsky, D. A., and G. M. Gates. 2005. An inventory of macrofungi observed in Tasmanian forests over a six-year period. Tasforests **16**:153-169.

Robinson, R. M., and N. L. Bougher. 2003. The response of fungi to fire in Jarrah (*Eucalyptus marginata*) and Karri (*Eucalyptus diversicolor*) forests of south-west Western Australia. Pages 269-289 in I. Abbott, and N. Burrows, editors. Fire in Ecosystems of South-west Western Australia: Impacts and Management. Backhuys Publishers, Leiden.

Rudophi, J., L. Gustafsson, and T. Berglund. 2007. Old-growth forest bryophytes and lichens in young boreal production forests in J. Rudolphi, editor. Bryophytes, Lichens and dead wood in young managed boreal forest. Swedish University of Agricultural Sciences - Department of Ecology, Uppsala.

Sader, S. A., D. J. Hayes, J. A. Hepinstall, M. Coan, and C. Soza. 2001. Forest change monitoring of a remote biosphere reserve. International Journal of Remote Sensing **22**:1937-1950.

Scott, G., T. Entwistle, T. May, and N. Stevens, editors. 1997. A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and Fungi. Environment Australia, Canberra.

Siitonen, J. 2001. Forest management, coarse woody debris and saproxylic organisims: Fennoscandian boreal forest example. Pages 11-42 in B. G. Jonsson, and N. Kruys, editors. Ecology of Woody Debris in Boreal Forests. Blackwell Science, Oxford.

Siitonen, P., A. Tanskanen, and A. Lehtinen. 2002. Method for selection of old-forest reserves. Conservation Biology **16**:1398-1408.

Söderström, L. 1988. The occurrence of epixylic bryophyte and lichen species on an old natural and a managed forest stand in northeast Sweden. Biological Conservation **45**:169-178.

Söderström, L. 1989. Regional distribution patterns of bryophytes species on spruce logs in northern Sweden. The Bryologist **92**:349-355.

Söderström, L., A. Seneca, and M. Santos. 2007. Rarity patterns in members of the Lophoziacea/Scapaniaceae complex occuring north of the tropics - implications for conservation. Biological Conservation **135**:352-359.

Solomon, M., A. S. Van Jaarsveld, H. C. Biggs, and M. H. Knight. 2003. Conservation targets for viable species assemblages? Biodiversity and Conservation **12**:2435-2441.

Thomas, J. W., J. F. Franklin, J. Gordon, and K. N. Johnson. 2006. The Northwest Forest Plan: origins, components, implementation experience, and suggestions for change. Conservation Biology **20**:277-287.

Turner, P. A. M. 2003. The ecology and conservation of bryophytes in Tasmanian wet eucalypt forest. Page 211. PhD Thesis, Geography and Environmental Studies. University of Tasmania, Hobart, Australia.

Turner, P. A. M., and E. J. Pharo. 2005. Influence of substrate type and forest age on bryophyte species distribution in Tasmania mixed forest. The Bryologist **108**:67-85.

Vanderpoorten, A., and P. Engels. 2002. The effects of environmental variation on bryophytes at a regional scale. Ecography **25**:513-522.

Vellak, K., and J. Paal. 1999. Diversity of bryophyte vegetation in some forest types in Estonia: a comparison of old unmanaged and managed forests. Biodiversity and Conservation **8**:1595-1620.

Vellak, K., A. Vellak, and N. Ingerpuu. 2007. Reasons for moss rarity: Study in three neighbouring countries. Biological Conservation **135**:360-368.

Virtanen, R., and J. O. Oksanen. 2007. The effects of habitat connectivity on cryptogam richness in boulder metacommunity. Biological Conservation **135**:415-422.

Yee, M., Z.-Q. Yaun, and C. Mohammed. 2001. Not just waste wood: decaying logs as key habitats in Tasmania's wet sclerophyll *Eucalyptus obliqua* production forests: the ecology of large and small logs compared. Tasforests **13**:119-128.

Zartman, C. E., and A. J. Shaw. 2006. Metapopulation extinction thresholds in rain forest remnants. The American Naturalist **167**:177–189

Surrogates for cryptogam conservation - associations between mosses, macrofungi, vascular plants and environmental variables.

Volume 2 - Appendices

Sapphire J.M. McMullan-Fisher B.Sc. (Honours – First class)

Submitted in fulfilment of the requirements for the
Degree of Doctor of Philosophy
at the School of Geography and Environmental Studies,
University of Tasmania - October 2008.

Supervisors:

Professor Jamie Kirkpatrick[1]
Doctor Tom May[2]
Doctor Emma Pharo[1]
Professor Richard Coleman[1]

[1] School of Geography and Environmental Studies, University of Tasmania
[2] National Herbarium of Victoria, Royal Botanic Gardens Melbourne

Table of Contents

Volume 2

Appendix 1. Site, locality, geology, and vegetation summary.

Site	Location	UTM Grid (Zone 55G)	Altitude (m)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
OGA	Tasmania, base of Mt Wellington Park, downhill ~80 m from the Lenah Valley Fire Track, ~250 m north of the intersection of Old Farm Road.	521820, 5250790	280	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest *Eucalyptus viminalis, E. obliqua, E. regnans, E. globulus* and *Acacia dealbata* overstorey with *Bedfordia salicina, Pittosporum bicolor* and *Coprosma quadrifida* understorey.
OGB	Tasmania, base of Mt Wellington Park, ~50 m uphill from the Lenah Valley Fire Track, ~320m north of the intersection of Old Farm Road.	521729, 5250984	330	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Eucalyptus obliqua, E. globulus* and *Acacia dealbata* overstorey with *Senecio linearifolius, Dactylis glomerata* and *Coprosma quadrifida* understorey.
OGC	Tasmania, base of Mt Wellington Park, ~ 50 m uphill from the Lenah Valley Fire Track, ~70 m south of the intersection with New Town Track.	521540, 5251650	340	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Eucalyptus obliqua, E. viminalis, E. globulus* and *E. tenuiramis* overstorey with *Acacia verniciflua, Pultenaea juniperina* and *Coprosma hirtella* understorey.
OGD	Tasmania, base of Mt Wellington Park, ~ 50 m downhill from the Lenah Valley Fire Track, ~75 m south of the intersection with New Town Track.	521666, 5251655	300	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Pomaderris apetala, Eucalyptus globulus* and *E. obliqua* overstorey with *Bedfordia salicina* and *Polystichum proliferum* understorey.
OGE	Tasmania, base of Mt Wellington Park, ~50 m south from the Middle Island Fire Trail, ~150 m from intersection of Lenah Valley Fire Track.	521544, 5250315	300	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Eucalyptus globulus, E. obliqua* and *Acacia dealbata* overstorey with *Bedfordia salicina* and *Coprosma quadrifida* dominating the understorey.

Appendix 1. Continued

Site	Location	UTM Grid (Zone 55G)	Altitude (meters)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
OGF	Tasmania, Taroona, Cartwright creek recreational area, ~700 m from Car Park, uphill ~10 m after second creek crossing.	528581, 5246373	100	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Eucalyptus globulus, E. obliqua* and *Pomaderris apetala* overstorey with a *Coprosma quadrifida, Beyeria viscosa* and *Lepidosperma laterale* understorey.
ROA	Tasmania, base of Mt Wellington Park, ~70m uphill from the Lenah Valley Fire Track, about 200 m, north of the Brushy Creek crossing.	521087, 5252097	380	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest with E*ucalyptus obliqua* and *E. regnans* overstorey with *Bedfordia salicina* and *Coprosma quadrifida* understorey.
ROB	Tasmania, base of Mt Wellington Park, ~50 m uphill from the Middle Island Fire Trail, ~280 m from intersection of Lenah Valley Fire Track.	521350, 5250255	350	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest, *Eucalyptus obliqua* dominant with *Bedfordia salicina, Coprosma quadrifida and Olearia argophylla* understorey.
ROC	Tasmania, base of Mt Wellington Park, ~80 m uphill from the Middle Island Fire Trail, ~40 m from creek crossing.	521240, 5250150	360	Permian mudstone & siltstone, 'Forcett Hills'	Wet eucalypt forest *Eucalyptus obliqua* dominant, with *Acacia verniciflua* understorey.
HEA	Tasmania, Peter Murrell Nature Reserve	524531, 5238321	50	Triassic predominantly sandstone, 'Maranoa Heights'	Heathy woodland with *Leucopogon collinus, L. ericoides, Hypolaena fastigiata, Pteridium esculentum* and *Epacris impressa* making up most of the vegetation cover, with scattered *Eucalyptus amygdalina* and *Allocasuarina monilifera*.

Appendix 1. Continued

Site	Location	UTM Grid (Zone 55G)	Altitude (meters)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
HEB	Tasmania, Peter Murrell Nature Reserve	524413, 5238290	40	Triassic predominantly sandstone, 'Maranoa Heights'	Heathy woodland with *Leptospermum scoparium, Leucopogon collinus, Schoenus lepidosperma, Hypolaena fastigiata, Pteridium esculentum* and *Epacris impressa* making up most of the vegetation cover, with scattered *Eucalyptus amygdalina, Allocasuarina monilifera,* and *A. littoralis*.
HEC	Tasmania, Peter Murrell Nature Reserve	524383, 5238318	40	Triassic predominantly sandstone, 'Maranoa Heights'	Heathy woodland with *Leptospermum scoparium, Leucopogon collinus, Pteridium esculentum* and *Schoenus lepidosperma* making up most of the vegetation cover with scattered *Eucalyptus amygdalina* and *Allocasuarina monilifera*.
HED	Tasmania, Knocklofty Park, about 30 m south of Trig maker at the top of Forest Road	524404, 5251459	230	Boundary between predominantly Triassic sandstone, 'Knocklofty' and Jurassic dolerite, 'Stony Hills'	Heathy woodland with *Poa* spp.*, Pultenaea juniperina, Stipa* spp.*, Danthonia spp*. and *Gonocarpus tetragynus* making up most of the vegetation cover with scattered *Eucalyptus amygdalina, E. globulus, E. ovata, E. pulchella, E. viminalis, Acacia dealbata* and *Exocarpos strictus*.
HEE	Tasmania, Knocklofty Park, Gully above the old quarry at the end of Arthur Street	'524549, 5252139	190	Predominantly Triassic sandstone, 'Knocklofty'	Heathy woodland with *Aotus ericoides, Epacris impressa, Gahnia radula* and *Poa sieberiana* making up most of the vegetation cover with scattered *Eucalyptus amygdalina* and *Acacia dealbata*.
HEF	Tasmania, Knocklofty Park, Gully above the old quarry at the end of Arthur Street	'524501, 5252158	180	Predominantly Triassic sandstone, 'Knocklofty'	Heathy woodland with *Leucopogon ericoides, L. virgatus, Poa sieberiana, Epacris impressa, Gahnia radula* and *Ozothamnus obcordatus* making up most of the vegetation cover with scattered *Eucalyptus amygdalina, E. obliqua, E. viminalis* and *Acacia dealbata*.

Appendix 1. Continued

Site	Location	UTM Grid (Zone 55G)	Altitude (meters)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
HEG	Tasmania, Peter Murrell Nature Reserve	524296, 5258469	40	Triassic predominantly sandstone, 'Maranoa Heights'	Heathy woodland with *Pteridium esculentum, Schoenus lepidosperma, Hypolaena fastigiata* and *Bossiaea cinerea* making up most of the vegetation cover.
GRA	Tasmania, University Reserve below Olina Grove Sports Field	525849, 5248672	190	Jurassic dolerite, 'Chimney Pot Hill'	Grassy woodland with *Themeda triandra, Lomandra longifolia* and *Poa rodwayi* making up most of the vegetation cover, with scattered *Eucalyptus ovata, E. pulchella* and *Acacia melanoxylon*.
GRB	Tasmania, University Reserve below Olina Grove Sports Field	525615, 5248894	210	Jurassic dolerite, 'Chimney Pot Hill'	Grassy woodland with *Themeda triandra, Poa rodwayi, Stipa* spp., *Lomandra longifolia* and *Gonocarpus tetragynus* making up most of the vegetation cover, with scattered *Eucalyptus pulchella, E. viminalis* and *Acacia dealbata*.
GRC	Tasmania, University Reserve below Olina Grove Sports Field	'525780, 5249030	170	Jurassic dolerite, 'Chimney Pot Hill'	Grassy woodland with *Themeda triandra, Poa rodwayi, Stipa* spp., *Lomandra longifolia, Gonocarpus tetragynus* and *Schoenus apogon* making up most of the vegetation cover, with scattered *Eucalyptus pulchella, E. viminalis E. ovata* and *Acacia dealbata*.
GRD	Tasmania, Queens Domain, about 200m north east of Loop Road	'526007, 5254426	120	Jurassic dolerite, 'Stony Hills'	Grassy woodland with *Themeda triandra* and *Stipa* spp. making up most of the vegetation cover, with scattered *Eucalyptus viminalis* and *Allocasuarina verticillata*.
GRE	Tasmania, Queens Domain, about 220m north of Loop Road	525878, 5254470	110	Jurassic dolerite, 'Stony Hills'	Grassy woodland with *Themeda triandra, Danthonia* spp. *Stipa* spp. and *Plantago lanceolata* making up most of the vegetation cover, with scattered *Eucalyptus viminalis E. globulus* and *Allocasuarina verticillata*.

Appendix 1. Continued

Site	Location	UTM Grid (Zone 55G)	Altitude (meters)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
GRF	Tasmania, Queens Domain, about 300m north, north east of the reservoirs	526317, 5254235	100	Jurassic dolerite, 'Stony Hills'	Grassy woodland with *Themeda triandra, Stipa* spp., *Poa rodwayi* and *Plantago lanceolata* making up most of the vegetation cover, with scattered *Eucalyptus viminalis*.
MTA	Tasmania, Summit of Mt Wellington Park.	518880, 5250355	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Orites acicularis, Orites revoluta, Poa gunnii* and *Pentachondra pumila* making up most of the vegetation cover.
MTB	Tasmania, Summit of Mt Wellington Park.	518801, 5250325	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Orites acicularis, Orites revoluta, Poa gunnii* and *Helichrysum backhousii* making up most of the vegetation cover.
MTC	Tasmania, Summit of Mt Wellington Park.	518830, 5250275	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Orites acicularis* and *Celmisia asteliifolia* making up most of the vegetation cover.
MTD	Tasmania, Summit of Mt Wellington Park.	518806, 5250414	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Poa gunnii* and *Olearia algida* making up most of the vegetation cover.
MTE	Tasmania, Summit of Mt Wellington Park.	518977, 5250690	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Orites revoluta, Poa* spp., *Epacris serpyllifolia, Celmisia asteliifolia* and *Ozothamnus ledifolius*making up most of the vegetation cover.
MTF	Tasmania, Summit of Mt Wellington Park.	518903, 5250690	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Poa* spp., *Celmisia asteliifolia, Ozothamnus hookeri* and *Pentachondra pumila* making up most of the vegetation cover.

Appendix 1. Continued

Site	Location	UTM Grid (Zone 55G)	Altitude (meters)	Geology and Landsystem (Davies 1988)	Vegetation survey summary.
MTG	Tasmania, Summit of Mt Wellington Park.	518811, 5250622	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath with *Epacris serpyllifolia, Empodisma minus, Abrotanella forsteroides, Poa* spp.*, Orites acicularis, Celmisia asteliifolia, Carpha alpina* and *Cyathodes dealbata* making up most of the vegetation cover. Mixed vegetation due to fire boundary between 1947 and 1962 fires.
MTH	Tasmania, Summit of Mt Wellington Park.	518722, 5250672	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath *Empodisma minus, Epacris serpyllifolia, Ozothamnus hookeri, Poa gunnii, Carpha alpina, Celmisia asteliifolia* and *Abrotanella forsteroides* making up most of the vegetation cover.
MTI	Tasmania, Summit of Mt Wellington Park.	518732, 5250612	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath *Empodisma minus, Epacris serpyllifolia, Sphagnum* spp.*, Richea scoparia, Abrotanella forsteroides* and *Oreobolus pumilio* making up most of the vegetation cover.
MTJ	Tasmania, Summit of Mt Wellington Park.	518930, 5250491	1240	Jurassic dolerite, 'Wellington Range'	Alpine heath *Epacris serpyllifolia, Poa* spp.*, Orites acicularis, Richea scoparia, Helichrysum backhousii* and *Celmisia asteliifolia* making up most of the vegetation cover.

Reference

Davies, J. B. 1988. Land Systems of Tasmania - Region 6: South East and Midlands - A resource classification survey. Department of Agriculture Tasmania, Hobart.

Appendix 2. Substrates, abbreviations and broad substrate classes for cryptogam surveys.

Substrate Class	Abbreviation	Substrate
Soil	g	'ground' soil
Soil	s	sandy soil
Burnt soil	btg	burnt soil
Rock	R	the total cover for rock
Cryptogamic	m	moss = the total covering of moss on plants, wood and the ground
Cryptogamic	a	algal mat
Cryptogamic	Lich	lichen
Humus	h	humus
Humus	pt	peat
Litter	L	litter
Litter	LL	leaf litter
Litter	FL	fern litter
Litter	L - yb	*Orites acicularis* leaf litter
Litter	CasL	*Allocasuarina* litter
Litter	dg	dead grass
Litter	bk	bark
Small Wood	w1	wood < 1 cm diameter
Small Wood	w2	wood 1-2 cm diameter
Small Wood	w5	wood 2-5 cm diameter
Large Wood	WX-Y	wood X-Y cm, where X was the minimum estimated diameter (> 5 cm) and Y was the maximum estimated diameter of wood
Large Wood	wst	stump
Burnt Wood	Btw5	burnt wood 1-5 cm diameter
Burnt Wood	BtwX-Y	burnt wood X-Y cm, where X was the minimum estimated diameter (> 5 cm) and Y was the maximum estimated diameter of burnt wood
Burnt Wood	Btwst	burnt stump
Miscellaneous	bt	burnt
Miscellaneous	pbt	partially burnt
Miscellaneous	Rot	old and rotting wood
Miscellaneous	D	herbivore dung
Live plant		live *plants* buttress, surveyed to a height of 2 m For example Eo-but = *Eucalyptus obliqua* buttress

Appendix 3. Site totals and presence of taxa on sites for vascular plants, mosses and macrofungi.

Identification classs (ID): 1 = named species, variety or equivelant, 2 = grouped to genus or groups of similar taxa within a genus, 3 = grouped at family or higher taxonomic levels. Lifeform or trophic group abbreviations (LF): t = tree, s = shrub, ps = prostrate shrub, h = herb, o = orchid, g = grass, se = sedge, cl = climber, f = fern, D = dendroid, F = fan, W = weft, M = matt, T = turf, C = cushion, lich = lichesed, myc = mycorrhizal, pa = parasitic and sap = saprotrophic.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
		Vascular plants total	**27**	**29**	**22**	**12**	**24**	**29**	**26**	**20**	**24**	**30**	**32**	**39**	**58**	**33**	**39**	**31**
		Mosses total	**18**	**22**	**18**	**21**	**19**	**24**	**30**	**20**	**13**	**4**	**1**	**6**	**14**	**3**	**3**	**4**
		Macrofungi total	**80**	**93**	**63**	**69**	**98**	**84**	**139**	**88**	**65**	**36**	**34**	**36**	**35**	**29**	**23**	**28**
ID	**LF**	**Taxon**	**OGA**	**OGB**	**OGC**	**OGD**	**OGE**	**OGF**	**ROA**	**ROB**	**ROC**	**HEA**	**HEB**	**HEC**	**HED**	**HEE**	**HEF**	**HEG**
1	h	*Abrotanella forsteroides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Acacia dealbata*	1	1	-	-	1	-	1	1	1	-	-	-	1	1	1	-
1	s	*Acacia genistifolia*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
1	t	*Acacia mearnsii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Acacia melanoxylon*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia myrtifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia suaveolens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	s	*Acacia ulicifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	s	*Acacia verticillata*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia verniciflua*	1	-	1	-	1	1	-	1	1	-	-	-	-	-	-	-
1	h	*Acaena echinata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Acaena montana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Acaena novae-zelandiae*	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
2	o	*Acianthus* spp.	-	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-
1	g	*Agrostis aemula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Agrostis capillaris*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Agrostis* spp.	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-
1	g	*Aira caryophyllea*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	g	*Aira* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Allocasuarina littoralis*	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-
1	s	*Allocasuarina monilifera*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	t	*Allocasuarina verticillata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Amperea xiphoclada*	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	1
1	h	*Anagallis arvensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
		Vascular plants total	65	60	69	36	35	44	31	27	30	34	24	30	40	41	36	28
		Mosses total	15	13	18	10	12	11	10	13	14	13	10	10	12	12	10	6
		Macrofungi total	16	11	9	6	11	5	5	2	3	2	3	9	7	2	4	5
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	h	*Abrotanella forsteroides*	-	-	-	-	-	-	-	-	-	1	-	1	1	1	1	-
1	t	*Acacia dealbata*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia genistifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Acacia mearnsii*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
1	t	*Acacia melanoxylon*	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia myrtifolia*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia suaveolens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia ulicifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia verticillata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Acacia verniciflua*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Acaena echinata*	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Acaena montana*	-	-	-	-	-	-	-	-	1	1	-	1	1	-	1	-
1	h	*Acaena novae-zelandiae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	o	*Acianthus* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Agrostis aemula*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	g	*Agrostis capillaris*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Agrostis* spp.	1	-	1	-	-	-	-	-	-	1	1	-	1	1	1	-
1	g	*Aira caryophyllea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Aira* spp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	t	*Allocasuarina littoralis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Allocasuarina monilifera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Allocasuarina verticillata*	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	s	*Amperea xiphoclada*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Anagallis arvensis*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	g	*Anthoxanthum odoratum*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Aotus ericoides*	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	1
1	se	*Arthropodium milleflorum*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Asperula gunnii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Astelia alpina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Asterotrichion discolor*	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	s	*Astroloma humifusum*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	s	*Baeckea gunniana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Baeckea ramosissima*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	t	*Banksia marginata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	t	*Bedfordia salicina*	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-
1	s	*Bellendena montana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Beyeria viscosa*	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Billardiera longiflora*	1	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-
1	s	*Boronia nana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Boronia parviflora*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	s	*Bossiaea cinerea*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	s	*Bossiaea prostrata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Brachyscina stricta*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Brachyscome spathulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Brachyscome* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	se	*Bulbine glauca*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Bursaria spinosa*	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-
2	o	*Caladenia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	se	*Carex appressa*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Carex breviculmis*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	se	*Carex gaudichaudiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Carpha alpina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Cassinia aculeata*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Cassytha glabella*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	cl	*Cassytha pubescens*	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-
1	h	*Celmisia asteliifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	g	*Anthoxanthum odoratum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Aotus ericoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Arthropodium milleflorum*	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Asperula gunnii*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	se	*Astelia alpina*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	1	1
1	t	*Asterotrichion discolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Astroloma humifusum*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Baeckea gunniana*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	ps	*Baeckea ramosissima*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Banksia marginata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Bedfordia salicina*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Bellendena montana*	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1
1	t	*Beyeria viscosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Billardiera longiflora*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	s	*Boronia nana*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Boronia parviflora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Bossiaea cinerea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Bossiaea prostrata*	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Brachyscina stricta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Brachyscome spathulata*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
2	h	*Brachyscome* spp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
1	se	*Bulbine glauca*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Bursaria spinosa*	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
2	o	*Caladenia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Carex appressa*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	se	*Carex breviculmis*	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Carex gaudichaudiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	se	*Carpha alpina*	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1
1	s	*Cassinia aculeata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Cassytha glabella*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Cassytha pubescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Celmisia asteliifolia*	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	h	*Celmisia saxifraga*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Centaurium erythraea*	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
2	o	*Chiloglottis* spp.	-	-	1	-	1	-	1	1	-	-	-	-	-	-	-	-
1	s	*Chrysanthemoides monilifera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Chrysocephalum apiculatum*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Cirsium arvense*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Cirsium vulgare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Clematis aristata*	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
1	cl	*Comesperma volubile*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	s	*Coprosma hirtella*	-	-	1	-	-	-	1	1	1	-	-	-	-	-	-	-
1	s	*Coprosma nitida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Coprosma quadrifida*	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
2	s	*Cotoneaster* spp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Craspedia alpina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Crataegus monogyna*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	ps	*Cyathodes dealbata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Cyathodes petiolaris*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Dactylis glomerata*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Danthonia pauciflora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Austrodanthonia setacea*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
2	g	*Danthonia* spp.	-	1	-	-	-	-	-	-	1	-	-	-	1	-	1	-
1	s	*Daviesia ulicifolia*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	g	*Deyeuxia monticola*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Deyeuxia quadriseta*	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1
1	g	*Deyeuxia* spp.	-	-	1	-	1	-	1	1	-	-	-	-	-	-	-	-
1	se	*Dianella brevicallis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Dianella revoluta*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	se	*Dianella tasmanica*	-	1	1	-	-	1	1	-	1	-	-	-	-	-	-	-
1	g	*Dichelachne crinita*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Dichelachne* spp.	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-
1	h	*Dichondra repens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Dillwynia cinerascens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	h	*Celmisia saxifraga*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	h	*Centaurium erythraea*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	o	*Chiloglottis* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Chrysanthemoides monilifera*	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Chrysocephalum apiculatum*	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Cirsium arvense*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	h	*Cirsium vulgare*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Clematis aristata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Comesperma volubile*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Coprosma hirtella*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Coprosma nitida*	-	-	-	-	-	-	-	1	1	1	-	-	1	1	-	1
1	s	*Coprosma quadrifida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	s	*Cotoneaster* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Craspedia alpina*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	-
1	s	*Crataegus monogyna*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Cyathodes dealbata*	-	-	-	-	-	-	1	1	1	-	-	1	1	1	1	1
1	s	*Cyathodes petiolaris*	-	-	-	-	-	-	1	1	1	-	-	1	1	-	-	-
1	g	*Dactylis glomerata*	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	g	*Danthonia pauciflora*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	g	*Austrodanthonia setacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Danthonia* spp.	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	s	*Daviesia ulicifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Deyeuxia monticola*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	g	*Deyeuxia quadriseta*	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	g	*Deyeuxia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	se	*Dianella brevicallis*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
1	se	*Dianella revoluta*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Dianella tasmanica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Dichelachne crinita*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
2	g	*Dichelachne* spp.	1	1	1	1	-	1	-	-	-	-	-	-	1	-	-	-
1	h	*Dichondra repens*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Dillwynia cinerascens*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	s	*Dillwynia glaberrima*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	s	*Dillwynia sericea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	se	*Diplarrena moraea*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	t	*Dodonaea viscosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Drosera arcturi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Drosera peltata*	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1
1	se	*Drymophila cyanocarpa*	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
1	g	*Ehrharta distichophylla*	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-
1	g	*Ehrharta stipoides*	1	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-
1	g	*Elymus scabrus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Empodisma minus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Epacris impressa*	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1
1	s	*Epacris serpyllifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Epilobium* spp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Erigeron karvinskianus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Erigeron pappocromus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Erigeron tasmanicus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus amygdalina*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1
1	t	*Eucalyptus globulus*	1	1	1	1	1	1	-	-	-	-	-	-	1	-	1	-
1	t	*Eucalyptus obliqua*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	1	-
1	t	*Eucalyptus ovata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	t	*Eucalyptus pulchella*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	t	*Eucalyptus regnans*	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus tenuiramis*	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-
1	t	*Eucalyptus viminalis*	1	-	1	-	-	1	-	-	-	-	-	-	1	1	1	-
2	h	*Euchiton* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Euphrasia collina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Euphrasia gibbsiae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Euphrasia striata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Exocarpos cupressiformis*	-	-	1	-	1	1	-	-	1	-	-	-	-	1	1	-
1	t	*Exocarpos humifusus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Exocarpus strictus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	s	*Dillwynia glaberrima*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Dillwynia sericea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Diplarrena moraea*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Dodonaea viscosa*	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Drosera arcturi*	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-
1	h	*Drosera peltata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Drymophila cyanocarpa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Ehrharta distichophylla*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Ehrharta stipoides*	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	g	*Elymus scabrus*	-	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	se	*Empodisma minus*	-	-	-	-	-	-	-	-	-	1	-	1	1	1	1	1
1	s	*Epacris impressa*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Epacris serpyllifolia*	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1
1	h	*Epilobium* spp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Erigeron karvinskianus*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Erigeron pappocromus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
1	h	*Erigeron tasmanicus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
1	t	*Eucalyptus amygdalina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus globulus*	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus obliqua*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus ovata*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus pulchella*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus regnans*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus tenuiramis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Eucalyptus viminalis*	-	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
2	h	*Euchiton* spp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Euphrasia collina*	-	-	-	-	-	-	1	1	-	1	-	-	-	1	-	-
1	h	*Euphrasia gibbsiae*	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1
1	h	*Euphrasia striata*	-	-	-	-	-	-	1	1	-	1	-	-	-	1	-	-
1	ps	*Exocarpos cupressiformis*	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Exocarpos humifusus*	-	-	-	-	-	-	1	1	1	-	1	1	-	-	-	1
1	s	*Exocarpus strictus*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	g	*Festuca plebeia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Gahnia grandis*	1	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-
1	se	*Gahnia radula*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
2	se	*Gahnia* spp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Galium aparine*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Galium* spp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	h	*Gentianella diemensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Geranium potentilloides*	1	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-
2	h	*Geranium* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	o	*Glossodia major*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
1	h	*Gnaphalium traversii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Gompholobium huegelii*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	h	*Gonocarpus montanus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Gonocarpus tetragynus*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1
1	h	*Goodenia lanata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	s	*Goodenia ovata*	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-
1	cl	*Hedera helix*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Ozothamnus rodwayi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Helichrysum dealbatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Helichrysum ledifolium*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Ozothamnus obcordatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
1	h	*Helichrysum scorpioides*	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1
1	s	*Ozothamnus hookeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Hibbertia acicularis*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	ps	*Hibbertia hirsuta*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	ps	*Hibbertia procumbens*	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
1	g	*Hierochloe fraseri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Hierochloe redolens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	f	*Histiopteris incisa*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Holcus lanatus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	f	*Huperzia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Hydrocotyle laxiflora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	g	*Festuca plebeia*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Gahnia grandis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Gahnia radula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	se	*Gahnia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Galium aparine*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Galium* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Gentianella diemensis*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	1	-
1	h	*Geranium potentilloides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Geranium* spp.	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	o	*Glossodia major*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Gnaphalium traversii*	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-
1	s	*Gompholobium huegelii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Gonocarpus montanus*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	h	*Gonocarpus tetragynus*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Goodenia lanata*	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Goodenia ovata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	cl	*Hedera helix*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Ozothamnus rodwayi*	-	-	-	-	-	-	1	1	1	1	-	1	1	1	1	1
1	h	*Helichrysum dealbatum*	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Helichrysum ledifolium*	-	-	-	-	-	-	1	1	1	1	1	-	-	1	-	-
1	s	*Ozothamnus obcordatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	h	*Helichrysum scorpioides*	-	1	1	-	-	-	-	-	-	1	1	1	1	-	-	-
1	s	*Ozothamnus hookeri*	-	-	-	-	-	-	1	1	-	1	1	1	1	1	1	1
1	s	*Hibbertia acicularis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Hibbertia hirsuta*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Hibbertia procumbens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Hierochloe fraseri*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-
1	g	*Hierochloe redolens*	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
1	f	*Histiopteris incisa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Holcus lanatus*	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	f	*Huperzia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	h	*Hydrocotyle laxiflora*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
2	h	*Hydrocotyle* spp.	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
1	h	*Hypercium gramineum*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Hypochaeris radicata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Hypolaena fastigiata*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	se	*Isolepis crassiuscula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	se	*Juncus* spp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	h	*Lagenifera stipitata*	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Laxmannia sessilifora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	h	*Leontodon taraxacoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma filiforme*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
1	se	*Lepidosperma gunnii*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
1	se	*Lepidosperma inops*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma laterale*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Leptocarpus tenax*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	s	*Leptomeria drupacea*	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-
1	h	*Leptorhynchos linearis*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Leptorhynchos squamatus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	ps	*Leptospermum rupestre*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leptospermum scoparium*	-	-	-	-	-	-	-	-	1	1	1	1	1	1	-	1
1	s	*Leucopogon collinus*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	s	*Leucopogon ericoides*	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-
1	s	*Leucopogon montanas*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leucopogon virgatus*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	1	1
1	h	*Linum marginale*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Linum trigynum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Lissanthe montana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Lissanthe strigosa*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	g	*Lolium* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lomandra longifolia*	-	-	-	-	-	1	-	-	-	-	-	1	1	1	1	-
1	s	*Lomatia tinctoria*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	se	*Luzula* spp.	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
1	f	*Lycopodium fastigiatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
2	h	*Hydrocotyle* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Hypercium gramineum*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Hypochaeris radicata*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	se	*Hypolaena fastigiata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Isolepis crassiuscula*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
2	se	*Juncus* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Lagenifera stipitata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Laxmannia sessilifora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Leontodon taraxacoides*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma filiforme*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma gunnii*	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma inops*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lepidosperma laterale*	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Leptocarpus tenax*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leptomeria drupacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Leptorhynchos linearis*	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Leptorhynchos squamatus*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Leptospermum rupestre*	-	-	-	-	-	-	1	1	1	-	-	-	1	1	-	-
1	s	*Leptospermum scoparium*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leucopogon collinus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leucopogon ericoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Leucopogon montanas*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	s	*Leucopogon virgatus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Linum marginale*	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Linum trigynum*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
1	s	*Lissanthe montana*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	s	*Lissanthe strigosa*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Lolium* spp.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	se	*Lomandra longifolia*	1	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Lomatia tinctoria*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	se	*Luzula* spp.	-	-	-	-	-	-	1	1	1	1	-	-	1	1	1	1
1	f	*Lycopodium fastigiatum*	-	-	-	-	-	-	-	1	1	-	1	1	1	1	1	1

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	f	*Lycopodium scariosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Melaleuca thyphelioides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	f	*Microsorum* spp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Mitrasacme montana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Mitrasacme pilosa*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	ps	*Monotoca empetrifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Monotoca glauca*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Notelaea ligustrina*	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia algida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Olearia argophylla*	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
1	s	*Olearia ericoides*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	s	*Olearia ledifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia pinifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia ramulosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia stellulata*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	s	*Olearia viscosa*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Opercularia varia*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
3	o	Orchidaceae spp.	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1	-
1	se	*Oreobolus pumilio*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Orites acicularis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Orites revoluta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Ourisia integrifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Oxalis perennans*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Derwentia derwentiana*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Pelargonium inodorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Pentachondra pumila*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Pentapogon quadrifidus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	s	*Persoonia juniperina*	-	-	-	-	-	-	-	-	-	1	-	1	1	1	1	-
1	h	*Petrorhagia prolifera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Nematolepis squamea*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2	h	*Picris* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Pimelea drupacea*	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	f	*Lycopodium scariosum*	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-
1	s	*Melaleuca thyphelioides*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
2	f	*Microsorum* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Mitrasacme montana*	-	-	-	-	-	-	1	1	1	-	1	1	-	-	1	1
1	h	*Mitrasacme pilosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Monotoca empetrifolia*	-	-	-	-	-	-	1	1	1	-	1	1	-	-	-	1
1	t	*Monotoca glauca*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Notelaea ligustrina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia algida*	-	-	-	-	-	-	-	1	1	1	-	1	1	1	1	-
1	t	*Olearia argophylla*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia ericoides*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia ledifolia*	-	-	-	-	-	-	1	1	1	-	1	1	1	-	-	1
1	s	*Olearia pinifolia*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	s	*Olearia ramulosa*	1	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia stellulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Olearia viscosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Opercularia varia*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	o	Orchidaceae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Oreobolus pumilio*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	1	-
1	s	*Orites acicularis*	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1
1	s	*Orites revoluta*	-	-	-	-	-	-	1	1	1	1	1	1	1	1	-	-
1	h	*Ourisia integrifolia*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
1	h	*Oxalis perennans*	1	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Derwentia derwentiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Pelargonium inodorum*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Pentachondra pumila*	-	-	-	-	-	-	1	1	1	1	1	1	1	-	1	-
1	g	*Pentapogon quadrifidus*	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Persoonia juniperina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Petrorhagia prolifera*	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
1	t	*Nematolepis squamea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Picris* spp.	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Pimelea drupacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	s	*Pimelea humilis*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
1	s	*Pimelea linifolia*	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	1
1	t	*Pittosporum bicolor*	1	-	1	1	1	-	1	1	1	-	-	-	-	-	-	-
1	h	*Plantago lanceolata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Plantago tasmanica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Plantago varia*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	g	*Poa gunnii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Poa pratensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Poa rodwayi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Poa sieberiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
2	g	*Poa* spp.	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-
1	f	*Polystichum proliferum*	1	-	-	1	1	-	1	1	-	-	-	-	-	-	-	-
1	t	*Pomaderris apetala*	1	1	-	1	1	1	1	1	-	-	-	-	-	-	-	-
1	h	*Poterium polygonum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	o	*Prasophyllum* spp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	f	*Pteridium esculentum*	1	1	1	1	1	-	1	1	1	1	1	1	-	1	1	1
2	o	*Pterostylis longifolia*	-	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-
1	o	*Pterostylis rufa*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	s	*Pultenaea daphnoides*	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-
1	s	*Pultenaea juniperina*	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-
1	ps	*Pultenaea pedunculata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Ranunculus* spp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Ranunculus lappaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Raphanus raphinastrum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Acion monocephalum*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	ps	*Rhytidosporum procumbens*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
1	s	*Richea scoparia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Richea sprengelioides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Romulea longifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Rosa rubiginosa*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	cl	*Rubus fruticosus*	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Rubus gunnianus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	s	*Pimelea humilis*	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Pimelea linifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Pittosporum bicolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Plantago lanceolata*	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Plantago tasmanica*	-	-	-	-	-	-	1	-	-	1	-	1	1	-	1	1
1	h	*Plantago varia*	1	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-
1	g	*Poa gunnii*	-	-	-	-	-	-	1	1	-	1	-	-	-	1	-	-
1	g	*Poa pratensis*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	g	*Poa rodwayi*	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-
1	g	*Poa sieberiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Poa* spp.	-	-	-	-	-	-	-	-	1	-	1	1	1	-	1	1
1	f	*Polystichum proliferum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	t	*Pomaderris apetala*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Poterium polygonum*	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	o	*Prasophyllum* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
1	f	*Pteridium esculentum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	o	*Pterostylis longifolia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	o	*Pterostylis rufa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Pultenaea daphnoides*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Pultenaea juniperina*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Pultenaea pedunculata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Ranunculus* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Ranunculus lappaceus*	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	h	*Raphanus raphinastrum*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	se	*Acion monocephalum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	ps	*Rhytidosporum procumbens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Richea scoparia*	-	-	-	-	-	-	1	1	1	1	-	-	1	1	1	1
1	s	*Richea sprengelioides*	-	-	-	-	-	-	1	1	1	1	1	1	-	-	-	1
1	se	*Romulea longifolia*	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	s	*Rosa rubiginosa*	1	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	cl	*Rubus fruticosus*	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Rubus gunnianus*	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	f	*Schizaea fistulosa*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
1	se	*Schoenus apogon*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	se	*Schoenus calyptratus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Schoenus lepidosperma*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1
1	h	*Senecio hispidulus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Senecio linearifolius*	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-
1	h	*Senecio pectinatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Senecio quadridentatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Senecio* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Sonchus* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Sprengelia incarnata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Austrostipa mollis*	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1
2	g	*Stipa* spp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
1	h	*Stylidium graminifolium*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1
1	s	*Styphelia adscendens*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1
1	h	*Taraxacum officinale*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Tasmannia lanceolata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Tetratheca labillardierei*	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
1	s	*Tetratheca pilosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Thelionema caespitosum*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
2	o	*Thelymitra spp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Themeda triandra*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	h	*Thismia rodwayi*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	h	*Tragopogon porrifolius*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Trifolium* D243	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Ulex europaeus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	se	*Uncinia compacta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	se	*Uncinia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Urospermum dalechampii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Veronica gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Vicia* spp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Viola hederacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	f	*Schizaea fistulosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Schoenus apogon*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Schoenus calyptratus*	-	-	-	-	-	-	1	-	-	1	1	1	-	-	-	-
1	se	*Schoenus lepidosperma*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Senecio hispidulus*	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Senecio linearifolius*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Senecio pectinatus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
1	h	*Senecio quadridentatus*	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-
2	h	*Senecio* spp.	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	h	*Sonchus* spp.	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	s	*Sprengelia incarnata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
1	g	*Austrostipa mollis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	g	*Stipa* spp.	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Stylidium graminifolium*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Styphelia adscendens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Taraxacum officinale*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Tasmannia lanceolata*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
1	s	*Tetratheca labillardierei*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Tetratheca pilosa*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Thelionema caespitosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	o	*Thelymitra spp.*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	g	*Themeda triandra*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Thismia rodwayi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Tragopogon porrifolius*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
2	h	*Trifolium* D243	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	s	*Ulex europaeus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	se	*Uncinia compacta*	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
2	se	*Uncinia* spp.	-	-	-	-	-	-	-	-	1	-	1	1	1	-	1	1
1	h	*Urospermum dalechampii*	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	h	*Veronica gracilis*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Vicia* spp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Viola hederacea*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	h	*Wahlenbergia saxicola*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	h	*Wahlenbergia* spp.	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-
1	se	*Wurmbea dioica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Zieria arborescens*	1	-	-	-	1	-	1	1	1	-	-	-	-	-	-	-
		Mosses																
2	T	*Acaulon* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Acrocladium chlamydophyllum*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
2	C	*Andreaea* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Barbula calycina*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	T	*Barbula torquata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Bartramia ithyphylla*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	M	*Blindia robusta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Breutelia pendula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	W	*Brachythecium rutabulum/salebrosum*	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
1	W	*Breutelia affinis*	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-
1	T	*Bryoerythrophyllum binnsii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	Bryum argenteum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	T	*Bryum* spp.	1	1	-	-	-	-	-	-	-	1	-	1	1	1	-	-
1	C	*Calyptopogon mnioides*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	M	*Calyptrochaeta apiculata*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	M	Calyptrochaeta otwayensis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	D	*Camptochaete arbuscula*	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
1	F	*Camptochaete deflexa*	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
2	T	*Campylopus* spp.	-	1	1	-	-	-	1	-	-	1	1	1	1	1	1	1
1	T	*Ceratodon purpureus*	1	1	-	-	-	-	-	-	-	-	-	1	1	-	1	1
1	T	*Conostomum pusillum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Dicranoloma billardierei*	-	1	1	-	1	1	1	1	1	-	-	-	-	-	-	-
1	T	*Dicranoloma menziesii*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	T	*Dicranoloma robustum*	-	1	1	1	-	-	1	-	1	-	-	-	-	-	-	-
1	C	*Didymodon australasiae*	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
2	T	Ditrichaceae spp.	1	-	1	-	1	1	1	1	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland									Alpine heath						
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	h	*Wahlenbergia saxicola*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	h	*Wahlenbergia* spp.	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	se	*Wurmbea dioica*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	s	*Zieria arborescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Mosses																
2	T	*Acaulon* spp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Acrocladium chlamydophyllum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	C	*Andreaea* spp.	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1
1	T	*Barbula calycina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Barbula torquata*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Bartramia ithyphylla*	-	-	-	-	-	-	-	1	-	-	1	1	-	1	-	-
1	M	*Blindia robusta*	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
1	M	*Breutelia pendula*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-
2	W	*Brachythecium rutabulum/salebrosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Breutelia affinis*	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Bryoerythrophyllum binnsii*	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	Bryum argenteum	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-
2	T	*Bryum* spp.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-
1	C	*Calyptopogon mnioides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Calyptrochaeta apiculata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	Calyptrochaeta otwayensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	D	*Camptochaete arbuscula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	F	*Camptochaete deflexa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	T	*Campylopus* spp.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	T	*Ceratodon purpureus*	1	1	1	1	1	1	1	-	1	-	-	-	-	-	-	-
1	T	*Conostomum pusillum*	-	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-
1	T	*Dicranoloma billardierei*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Dicranoloma menziesii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Dicranoloma robustum*	-	-	-	-	-	-	1	1	1	-	-	-	1	-	1	1
1	C	*Didymodon australasiae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	T	Ditrichaceae spp.	-	-	-	-	-	-	1	1	1	1	1	1	1	1	-	1

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	T	*Fissidens curvatus* var. *curvatus*	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-
1	T	*Fissidens curvatus* var. *inclinabilis*	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Fissidens leptocladus*	-	1	-	1	-	1	1	1	-	-	-	-	-	-	-	-
1	T	*Fissidens taylorii*	1	1	1	-	-	-	1	-	1	-	-	-	1	-	-	-
1	T	*Fissidens tenellus*	1	-	1	1	1	1	1	1	-	-	-	-	1	-	-	-
1	C	*Grimmia pulvinata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	C	*Grimmia* spp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
2	D	*Hypnodendron* sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	W	*Hypnum cupressiforme*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
1	D	*Hypopterygium didictyon*	-	-	-	1	1	-	1	1	1	-	-	-	-	-	-	-
2	D	*Hypopterygium sp.*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	W	*Isopterygium aff. minutirameum*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	F	*Kindbergia praelonga*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Lembophyllum clandestinum*	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-	-
1	W	*Lembophyllum divulsum*	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
1	T	*Leptotheca gaudichaudii*	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	T	*Leucobryum candidum*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	C	*Notoligotrichum* aff. *australe*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Orthodontium lineare*	-	-	1	-	1	1	-	1	1	-	-	-	-	-	-	-
1	C	*Orthotrichum tasmanicum*	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	M	*Philonotis australiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Philonotis* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Polytrichum commune*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Polytrichum juniperinum*	-	1	-	-	-	-	1	-	-	-	-	1	1	-	-	-
1	T	Pottiaceae sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	T	Pottiaceae spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Pseudoleskea imbricata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	M	*Ptychomnion aciculare*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
2	M	*Racocarpus* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	W	*Racomitrium* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	T	*Fissidens curvatus* var. *curvatus*	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	T	*Fissidens curvatus* var. *inclinabilis*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	T	*Fissidens leptocladus*	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
1	T	*Fissidens taylorii*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	T	*Fissidens tenellus*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	C	*Grimmia pulvinata*	-	-	-	-	-	-	1	1	1	-	1	1	-	-	-	-
2	C	*Grimmia* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	D	*Hypnodendron* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Hypnum cupressiforme*	-	-	-	-	-	-	-	1	-	1	-	-	1	1	1	-
1	D	*Hypopterygium didictyon*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
2	D	*Hypopterygium sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Isopterygium aff. minutirameum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	F	*Kindbergia praelonga*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Lembophyllum clandestinum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Lembophyllum divulsum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Leptotheca gaudichaudii*	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
1	T	*Leucobryum candidum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	C	*Notoligotrichum* aff. *australe*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	T	*Orthodontium lineare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	C	*Orthotrichum tasmanicum*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	M	*Philonotis australiensis*	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Philonotis* sp. A	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Polytrichum commune*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-
1	T	*Polytrichum juniperinum*	-	-	1	-	-	-	1	1	1	1	1	1	1	1	1	1
1	T	Pottiaceae sp. A	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
2	T	Pottiaceae spp.	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	M	*Pseudoleskea imbricata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Ptychomnion aciculare*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-
2	M	*Racocarpus* spp.	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-
2	W	*Racomitrium* spp.	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	M	*Racopilum cuspidigerum* var. *convolutaceum*	1	1	-	1	1	1	1	1	-	-	-	-	-	-	-	-
1	M	*Rhizogonium distichum*	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-
1	M	*Rhizogonium novaehollandiae*	-	-	1	1	1	-	-	1	1	-	-	-	-	-	-	-
1	M	*Rhynchostegiella muriculata*	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	T	*Rosulabryum* aff. *campylothecium*	-	1	-	-	-	-	1	-	-	1	-	1	1	-	1	-
1	T	*Rosulabryum billardierei*	1	1	-	-	-	1	1	1	-	1	-	-	1	-	-	1
2	W	Sematophyllaceae spp.	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
2	C	*Sphagnum* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Tortula rubra*	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
1	D	*Thamnobryum pumilum*	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
1	W	*Thuidium sparsum*	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-
1	T	*Tortella calycina/truncata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Tortula muralis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Weissia controversa*	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-	-
1	W	*Wijkia extenuata*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
		Macrofungi																
1	sap	Agaric sp. A	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
2	sap	Agaric spp. I	-	1	-	-	1	-	-	-	-	1	1	1	-	-	-	1
1	sap	*Agaricus* sp. A	1	1	1	1	-	1	1	1	-	-	-	-	1	-	-	-
1	sap	*Agaricus* sp. B	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Agaricus* sp. C	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2	sap	*Agaricus* spp. I	1	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-
1	myc	*Aleuria rhenana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Amanita aff. murinaster*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Amanita griselloides* complex	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	myc	*Amanita xanthocephala*	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
1	sap	*Anthracophyllum archeri*	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	sap	*Antrodiella citrea*	1	1	1	1	1	1	1	1	-	-	-	-	1	-	-	-
1	myc	*Aphelaria* sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	myc	*Aphelaria* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland									Alpine heath							
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	M	*Racopilum cuspidigerum* var. *convolutaceum*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Rhizogonium distichum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Rhizogonium novaehollandiae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	M	*Rhynchostegiella muriculata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Rosulabryum* aff. *campylothecium*	1	1	1	-	-	-	-	1	-	-	1	-	-	-	-	-
1	T	*Rosulabryum billardierei*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	W	Sematophyllaceae spp.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2	C	*Sphagnum* spp.	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-
1	T	*Tortula rubra*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	D	*Thamnobryum pumilum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	W	*Thuidium sparsum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Tortella calycina/truncata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	T	*Tortula muralis*	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	T	*Weissia controversa*	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1	W	*Wijkia extenuata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
		Macrofungi																
1	sap	Agaric sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	Agaric spp. I	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Agaricus* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Agaricus* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Agaricus* sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Agaricus* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Aleuria rhenana*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	myc	*Amanita aff. murinaster*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Amanita griselloides* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Amanita xanthocephala*	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Anthracophyllum archeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Antrodiella citrea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Aphelaria* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Aphelaria* sp. B	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	pa	*Armillaria novaezelandiae*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Artomyces* spp.	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	*Ascocoryne sarcoides*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Austroboletus* aff. *occidentalis*	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-
2	myc	*Austropaxillus muelleri* complex	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Bolbitius* sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	myc	*Boletellus ananiceps*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	sap	*Bovista* sp. A	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	1
1	sap	*Byssomerulius corium*	1	-	1	1	1	-	1	1	-	-	-	-	-	1	-	-
1	sap	*Callistosporium* sp. A	1	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
2	sap	*Calocera* spp.	1	1	1	1	1	-	1	1	1	1	-	-	1	1	1	-
1	sap	*Calyptella* sp. A	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	sap	*Campanella* sp. A	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	sap	*Chlorociboria aeruginascens* comp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Clavaria amoena* complex	-	1	1	-	1	1	1	-	-	-	1	-	-	-	-	1
2	myc	*Clavaria miniata* complex	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
2	myc	*Clavaria* spp. I	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-
1	myc	Clavariaceae sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina redoleo-alii*	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina* sp. B	-	-	-	1	-	1	1	-	1	-	-	-	-	-	-	-
1	myc	*Clavulina tasmanica*	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
1	myc	*Clavulina vinaceocervina*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Clitocybe* sp. A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Collybia aff. eucalyptorum*	1	1	1	1	1	-	1	1	1	-	-	-	-	-	-	-
1	sap	*Collybia* sp. A	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-
2	sap	*Collybia* spp. I	-	1	1	-	1	-	-	-	-	-	-	-	1	-	-	-
1	myc	*Coltricia cinnamomea*	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-
2	sap	*Conocybe* spp.	-	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
1	sap	*Coprinus* aff. *disseminatus*	1	1	-	1	-	-	1	1	-	-	-	-	1	-	-	-
1	sap	*Coprinus* sp. A	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-
3	sap	Corticiaceae spp.	1	-	1	1	1	1	1	1	1	1	-	1	1	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	pa	*Armillaria novaezelandiae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Artomyces* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Ascocoryne sarcoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Austroboletus* aff. *occidentalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Austropaxillus muelleri* complex	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Bolbitius* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Boletellus ananiceps*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Bovista* sp. A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Byssomerulius corium*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Callistosporium* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Calocera* spp.	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Calyptella* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Campanella* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Chlorociboria aeruginascens* comp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Clavaria amoena* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Clavaria miniata* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Clavaria* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	Clavariaceae sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina redoleo-alii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina tasmanica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Clavulina vinaceocervina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Clitocybe* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Collybia aff. eucalyptorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Collybia* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Collybia* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Coltricia cinnamomea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Conocybe* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Coprinus* aff. *disseminatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Coprinus* sp. A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	sap	Corticiaceae spp.	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	myc	*Cortinarius abnormis*	1	1	1	1	-	1	1	1	1	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *alboviolaceus*	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *austroviolaceus*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *violaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
1	myc	*Cortinarius archeri*	1	1	1	-	1	-	-	-	1	-	-	-	-	-	-	-
1	myc	C*ortinarius fibrillosus*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1
1	myc	*Cortinarius rotundisporus*	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. B	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. C	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. D	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. E	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
2	myc	*Cortinarius* spp. I	1	1	1	1	1	-	1	1	1	1	1	1	1	-	1	1
2	myc	*Cortinarius* spp. II	1	-	-	1	1	-	1	-	-	-	1	1	-	-	-	-
2	myc	*Cortinarius* spp. III	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
2	myc	*Cortinarius* spp. IV	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1
1	sap	*Crepidotus* aff. *nephrodes*	1	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Crepidotus eucalyptorum*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	*Crinipellis* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Cystoderma muscicola*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Cystolepiota* sp. A	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
1	myc	*Dermocybe austroveneta*	-	-	1	1	1	-	1	1	1	-	-	-	1	-	-	-
2	myc	*Dermocybe clelandii* complex	1	1	1	1	1	1	-	1	1	1	1	1	1	-	-	1
1	myc	*Dermocybe* sp. A	-	1	1	1	1	1	1	1	1	-	1	-	-	-	-	-
1	myc	*Descolea recedens*	-	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-
1	myc	*Descolea* sp. A	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Discinella terrestris*	1	1	-	-	1	-	1	1	1	-	1	1	1	-	-	1
1	sap	Discomycete sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. B	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. C	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. D	1	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	Discomycete sp. E	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. F	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	myc	*Cortinarius abnormis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *alboviolaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *austroviolaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* aff. *violaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius archeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	C*ortinarius fibrillosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius rotundisporus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Cortinarius* sp. E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Cortinarius* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Cortinarius* spp. II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Cortinarius* spp. III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Cortinarius* spp. IV	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Crepidotus* aff. *nephrodes*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Crepidotus eucalyptorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Crinipellis* sp. A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Cystoderma muscicola*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Cystolepiota* sp. A	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	myc	*Dermocybe austroveneta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Dermocybe clelandii* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Dermocybe* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Descolea recedens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Descolea* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Discinella terrestris*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	sap	Discomycete sp. A	-	-	-	-	-	-	1	1	1	1	1	-	1	1	-	1
1	sap	Discomycete sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	Discomycete sp. F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
2	sap	Discomycete spp. I	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-
2	sap	Discomycete spp. II	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	1
2	sap	Discomycete spp. III	1	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-
2	sap	Discomycete spp. IV	-	1	1	1	1	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Entoloma panniculum*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Entoloma* sp. A	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	sap	*Entoloma* sp. B	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
2	sap	*Entoloma* spp. I	-	-	-	1	1	-	1	1	1	1	1	1	1	1	1	1
1	sap	*Entoloma viridomarginatum*	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
1	sap	*Exidia* sp. A	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	myc	*Fistulinella* aff. *prunicolor*	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	myc	*Fistulinella mollis*	1	1	-	-	-	-	-	1	-	1	-	1	-	-	-	1
1	sap	*Fuligo septica*	1	1	1	-	-	1	1	1	-	-	1	-	-	-	-	-
1	sap	*Galerina* aff. *patagonica*	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-
2	sap	*Galerina muscolignosa* complex	-	1	1	1	1	1	1	1	1	-	-	-	-	-	-	1
1	sap	*Galerina patagonica*	1	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-
2	sap	*Galerina* spp. I	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-
2	sap	*Geastrum triplex* complex	-	-	1	-	-	1	1	1	-	-	-	-	-	-	-	-
1	myc	*Geoglossum* aff. *glutinosum*	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
1	sap	*Gloiocephala* sp. A	1	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus allantopus*	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-
2	sap	*Gymnopilus eucalyptorum* comple	1	1	-	1	1	-	1	1	-	-	-	-	1	-	-	-
1	sap	*Gymnopilus ferruginosus*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus junonius*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus moabus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopus alkalivirens*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Hebeloma* sp. A	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
1	sap	*Heterotextus peziziformis*	1	1	1	-	1	1	1	1	1	1	1	-	1	1	1	-
1	sap	*Hohenbuehelia* aff. *clelandii*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Hohenbuehelia bingarra*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hydnellum* sp. A	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
1	myc	*Hydnum repandum*	1	1	-	-	-	1	1	1	1	1	1	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
2	sap	Discomycete spp. I	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-
2	sap	Discomycete spp. II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	Discomycete spp. III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	Discomycete spp. IV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Entoloma panniculum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Entoloma* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Entoloma* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Entoloma* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Entoloma viridomarginatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Exidia* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Fistulinella* aff. *prunicolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Fistulinella mollis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Fuligo septica*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Galerina* aff. *patagonica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Galerina muscolignosa* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Galerina patagonica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Galerina* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Geastrum triplex* complex	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Geoglossum* aff. *glutinosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gloiocephala* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus allantopus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Gymnopilus eucalyptorum* comple	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus ferruginosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus junonius*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopilus moabus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Gymnopus alkalivirens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Hebeloma* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Heterotextus peziziformis*	-	1	-	-	-	-	1	1	-	1	1	1	1	-	-	1
1	sap	*Hohenbuehelia* aff. *clelandii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hohenbuehelia bingarra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hydnellum* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Hydnum repandum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	sap	*Hygrocybe* aff. *minutula*	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* aff. *pratensis*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	sap	*Hygrocybe astatogala*	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe cantharellus*	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-
1	sap	*Hygrocybe chlorophana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe graminicolor*	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-
1	sap	*Hygrocybe miniata*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	sap	*Hygrocybe rodwayi*	-	1	-	-	1	1	1	1	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* sp. A	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* sp. B	-	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Hygrophorus involutus*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Hygrotrama* sp. A	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Hypholoma fasciculare*	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-
1	myc	*Inocybe australiensis*	1	-	1	-	1	1	-	-	1	-	-	-	-	-	-	-
2	myc	*Inocybe dewrangia* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	myc	*Laccaria lateritia*	1	-	-	-	1	-	1	-	-	-	-	-	1	1	1	-
1	myc	*Laccaria* sp. B	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
1	sap	*Lachnum lachnoderma*	1	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-
1	myc	*Lactarius* aff. *sepiaceus*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1	myc	*Lactarius eucalypti*	1	-	1	1	1	-	1	-	1	1	1	-	1	-	-	-
2	sap	*Lentinellus hepatotrichus* complex	1	-	-	1	-	1	1	1	-	1	-	-	-	-	-	-
1	sap	*Leotia lubrica*	-	1	-	-	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	*Lepiota* aff. *fuliginosa*	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1
1	sap	*Lepiota* aff. *haemorrhagica*	1	1	-	-	1	-	-	1	1	-	-	-	-	-	1	-
2	sap	*Lepiota* spp. I	1	1	1	1	1	1	1	1	-	1	1	1	-	1	-	-
1	sap	*Lycoperdon* aff. *pyriforme*	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Macrotyphula juncea*	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-	-
1	lich	*Marasmiellus affixus*	1	1	-	1	1	-	1	1	-	-	-	-	-	-	-	-
1	sap	*Marasmius elegans*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Marasmius* sp. A	-	1	-	1	-	-	-	1	1	-	1	-	-	-	-	-
1	sap	*Marasmius* sp. B	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
2	sap	*Marasmius* spp. I	1	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	sap	*Hygrocybe* aff. *minutula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* aff. *pratensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe astatogala*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe cantharellus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe chlorophana*	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-
1	sap	*Hygrocybe graminicolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe miniata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe rodwayi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrocybe* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrophorus involutus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hygrotrama* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Hypholoma fasciculare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Inocybe australiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Inocybe dewrangia* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Laccaria lateritia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Laccaria* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Lachnum lachnoderma*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Lactarius* aff. *sepiaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Lactarius eucalypti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Lentinellus hepatotrichus* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Leotia lubrica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Lepiota* aff. *fuliginosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Lepiota* aff. *haemorrhagica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Lepiota* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Lycoperdon* aff. *pyriforme*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Macrotyphula juncea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	lich	*Marasmiellus affixus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Marasmius elegans*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Marasmius* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Marasmius* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Marasmius* spp. I	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
2	sap	*Marasmius* spp. II	1	1	1	1	1	1	1	1	-	1	-	1	1	1	-	-
1	sap	*Melanotus hepatochrous*	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Mollissia* aff. *cinerea*	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* aff. *neerimensis*	1	1	-	1	1	1	1	1	1	1	1	1	-	1	-	-
1	sap	*Mycena* aff. *tallangattensis*	-	-	-	-	-	1	-	-	-	1	-	-	-	1	1	-
1	sap	*Mycena albidofusca*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena austrofilopes*	1	1	1	1	1	1	1	1	-	-	1	-	1	-	-	-
1	sap	*Mycena austrororida*	-	1	1	1	-	1	1	-	1	-	-	-	-	-	-	-
2	sap	*Mycena banksiae* complex	1	1	1	-	1	1	1	1	1	1	-	-	1	-	1	-
1	sap	*Mycena cystidiosa*	-	1	-	-	1	1	-	1	1	-	-	-	-	-	-	-
2	sap	*Mycena epipterygia* complex	1	1	1	1	1	1	-	1	1	-	-	-	-	-	-	-
1	sap	*Mycena interrupta*	1	1	1	1	1	1	1	1	1	-	-	-	1	-	-	-
1	sap	*Mycena kurramulla*	-	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-
1	sap	*Mycena kuurkacea*	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1
1	sap	*Mycena mulawaestris*	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Mycena nargan*	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* sp. A	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	*Mycena* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* sp. C	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1
1	sap	*Mycena* sp. D	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
2	sap	*Mycena* spp. I	1	1	-	1	-	1	1	-	1	-	-	-	-	-	-	-
2	sap	*Mycena* spp. II	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	sap	*Mycena* spp. III	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-
2	sap	*Mycena subgalericulata* complex	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
2	sap	*Mycena vinacea* complex	1	1	-	-	-	-	1	-	1	-	-	-	1	-	-	-
1	sap	*Mycena viscidocruenta*	-	-	1	-	1	-	1	1	-	-	-	-	1	1	-	-
1	sap	*Myxomycidium pendulum*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Nidula niveo-tomentsa*	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1
1	lich	*Omphalina chromacea*	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	1
1	lich	*Omphalina* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	lich	*Omphalina* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	lich	*Omphalina umbellifera*	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
2	sap	*Marasmius* spp. II	1	-	-	-	1	-	1	-	-	-	1	1	1	-	1	1
1	sap	*Melanotus hepatochrous*	1	-	1	-	1	-	-	-	-	-	-	-	1	-	-	-
1	sap	*Mollissia* aff. *cinerea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* aff. *neerimensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* aff. *tallangattensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena albidofusca*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena austrofilopes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena austrororida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena banksiae* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena cystidiosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena epipterygia* complex	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	sap	*Mycena interrupta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena kurramulla*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena kuurkacea*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena mulawaestris*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena nargan*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
1	sap	*Mycena* sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena* sp. D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena* spp. II	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2	sap	*Mycena* spp. III	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena subgalericulata* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Mycena vinacea* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Mycena viscidocruenta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Myxomycidium pendulum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Nidula niveo-tomentsa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	lich	*Omphalina chromacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	lich	*Omphalina* sp. A	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-
1	lich	*Omphalina* sp. B	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-
1	lich	*Omphalina umbellifera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	sap	*Panellus stipticus*	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Peziza* sp. A	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
1	myc	*Peziza* sp. B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Phellinus wahlbergii*	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
1	sap	*Pholiota highlandensis*	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	1
1	sap	*Pholiota multicingulata*	1	1	1	1	1	-	1	1	-	-	-	-	-	1	1	-
1	sap	*Pholiota* sp. A	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-
1	sap	*Pholiota* sp. B	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota squarrosipes*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Pisolithus* aff. *arhizus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
1	sap	*Plectania campylospora*	-	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-
1	sap	*Pleuroflammula* aff. *flammea*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pluteus atromarginatus*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pluteus* sp. A	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Podoscypha petalodes*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Podoserpula pusio*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Polyporus* sp. A	-	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-
2	sap	Polypore spp.	-	-	1	-	1	-	1	1	1	-	-	-	1	1	-	-
1	myc	*Porpoloma* sp. A	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Psathyrella echinata*	1	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-
2	sap	*Psathyrella* spp.	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
2	sap	*Pseudobaespora* spp.	1	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Psilocybe* aff. *musci*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
1	sap	*Psilocybe subaeruginosa*	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
1	myc	*Pulvinula miltina*	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	1
1	sap	*Punctularia strigosozonata*	1	1	1	1	1	1	1	-	1	1	-	1	-	-	-	-
1	sap	*Pycnoporus cinnabarinus*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
1	myc	*Ramaria lorithamnus*	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Ramariopsis bicolor*	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
2	myc	*Ramariopsis corniculata* complex	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	myc	*Ramariopsis pulchella*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	sap	*Panellus stipticus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Peziza* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Peziza* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Phellinus wahlbergii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota highlandensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota multicingulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pholiota squarrosipes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Pisolithus* aff. *arhizus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Plectania campylospora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pleuroflammula* aff. *flammea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pluteus atromarginatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pluteus* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Podoscypha petalodes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Podoserpula pusio*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Polyporus* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	Polypore spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Porpoloma* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Psathyrella echinata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Psathyrella* spp.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Pseudobaespora* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Psilocybe* aff. *musci*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1	sap	*Psilocybe subaeruginosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Pulvinula miltina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Punctularia strigosozonata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Pycnoporus cinnabarinus*	1	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-
1	myc	*Ramaria lorithamnus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Ramariopsis bicolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Ramariopsis corniculata* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Ramariopsis pulchella*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
2	myc	*Ramariopsis* spp. I	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	sap	*Resupinatus subapplicatus*	-	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Rhodocollybia butyracea*	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	1
1	sap	*Rhodocollybia* sp. A	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-
2	sap	*Rhodocybe* spp. I	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
2	sap	*Rhodocybe* spp. II	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
1	sap	*Rickenella fibula*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Ripartites* sp. A	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Russula* aff. *cyanoxantha*	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-
2	myc	*Russula clelandii* complex	-	-	1	-	-	-	1	-	-	1	-	-	-	-	-	-
1	myc	*Russula neerimea*	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	-
1	myc	*Russula purpureoflava*	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Simocybe phlebophora*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	sap	Stereales spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
1	sap	*Stereum hirsutum*	1	-	1	-	-	-	1	-	-	-	-	1	-	-	-	1
1	sap	*Stereum ostrea*	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	sap	*Stereum illudens*	1	1	1	1	1	1	-	1	1	-	-	-	1	1	1	-
1	sap	*Stropharia semiglobata*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
1	sap	*Stropharia* sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3	sap	Strophariaceae spp.	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
1	sap	*Torrediella eucalypti*	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-
1	sap	*Torrendiella clealandii*	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
1	sap	*Trametes versicolor*	-	1	1	1	-	-	-	1	-	-	-	-	-	-	-	1
1	pa	*Tremella fuciformis*	-	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-
2	pa	*Tremella mesenterica* complex	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	pa	*Tremella* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Tricholoma* spp. I	-	1	1	-	1	-	1	-	-	-	-	-	-	1	-	-
1	myc	Tricholomataceae sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	Tricholomataceae sp. B	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1	sap	*Trogia* sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
2	sap	*Tubaria* spp.	-	1	-	-	-	1	1	1	-	-	-	1	1	-	1	-
1	myc	*Xerocomus* sp. A	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
2	myc	*Ramariopsis* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Resupinatus subapplicatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Rhodocollybia butyracea*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1	sap	*Rhodocollybia* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Rhodocybe* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Rhodocybe* spp. II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Rickenella fibula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Ripartites* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Russula* aff. *cyanoxantha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Russula clelandii* complex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Russula neerimea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Russula purpureoflava*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Simocybe phlebophora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	sap	Stereales spp.	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Stereum hirsutum*	1	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-
1	sap	*Stereum ostrea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Stereum illudens*	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Stropharia semiglobata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Stropharia* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	sap	Strophariaceae spp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
1	sap	*Torrediella eucalypti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Torrendiella clealandii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Trametes versicolor*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
1	pa	*Tremella fuciformis*	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
2	pa	*Tremella mesenterica* complex	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	pa	*Tremella* sp. A	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2	myc	*Tricholoma* spp. I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	Tricholomataceae sp. A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
1	myc	Tricholomataceae sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Trogia* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	sap	*Tubaria* spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	myc	*Xerocomus* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Wet forest									Heathy woodland						
ID	LF	Taxon	OGA	OGB	OGC	OGD	OGE	OGF	ROA	ROB	ROC	HEA	HEB	HEC	HED	HEE	HEF	HEG
1	sap	*Xerula australis*	1	1	1	-	1	-	-	1	1	-	-	-	-	-	-	-
1	sap	*Xylaria* sp. B	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
1	sap	*Xylaria* sp. A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3.

		Vegetation Type	Grassy woodland						Alpine heath									
ID	LF	Taxon	GRA	GRB	GRC	GRD	GRE	GRF	MTA	MTB	MTC	MTD	MTE	MTF	MTG	MTH	MTI	MTJ
1	sap	*Xerula australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Xylaria* sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	sap	*Xylaria* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. Macrofungal identifications and collections

Nomenclature and classification

Nomenclature follows (May *et al.* 2004) and the classification hierarchy follows (Kirk *et al.* 2001) except that for Ascomycota, the Discomycetes are utilised as an informal taxon for disc-like fungi not identified to specific genera within either the Leotiales or Pezizales. The taxa are ordered alphabetically by phylum, then order, then genus. Within a genus the named species, species with affinities to published species and named species complexes (e.g. *Mycena epipterygia* complex) are listed first alphabetically by species epithet, followed by un-named single taxa and morpho-species.

Measurements

Means (x) given are based on a minimum of 5 measurements per collection. This is a relatively small number of measurements but is sufficient for purposes of identification. It is possible that the measurements presented will have a smaller range than reported in the literature for the particular species. When comparing collection measurements with published descriptions, differences are not mentioned unless they exceed the published description range by ±25%. Colours for microscopic features were recorded in 5% KOH unless otherwise stated.

Collections

Numerous collections were made, but most of these were suboptimal material, because few fruit-bodies were present on the site at the time of the survey. All collections made during the study are listed below under the relevant taxon in the form ‘SMF’ followed by the collection number. High-quality collections that have a reasonable number of fruit-bodies in good condition have been lodged at the Tasmanian Herbarium (HO) or the National Herbarium of Victoria (MEL). Other collections will be kept until after thesis completion. Taxa for which collections were not made or vouchers are not lodged are either highly distinctive in the field, such as Fungimap target species (Grey and Grey 2005), or occasionally very broad group taxa which contain a number of species, such as the group for small, white species of *Mycena*.

Ascomycota

Discomycetes

Discomycetes is an informal grouping for Ascomycota with disc or occasionally cup-shaped fruit-bodies that were not able to be assigned to particular genera or species, and which may belong to Leotiales or Pezizales.

Discomycete sp. A

This small, orange ascomycete is periodically abundant on leaf litter (Figure 1). This taxon was only observed growing on *Orites acicularis* leaf litter.

Macro-Characters Apothecia 0.5 mm across to <1 mm deep; orange cup with narrow stipe; hymenium brighter than the outer surface.

Micro-characters Ascospores 9.9-12.1 x 3.3-4.4 (x = 11.3 x 3.8 µm). Paraphyses 1-2 µm wide, inamyloid, not septate. Asci are 8-spored, with amyloid lines at ascus apex. Paraphyses and asci apex are the same height. Sterile tissue at base is brown.

Collections SMF290, SMF1115

Images AscYOrcup1115L

Discomycete sp. B

This buff disk has dark warts and a long elegant stem (Figure 1).

Macro-characters Apothecia 3-10 mm across to 15 mm deep; cupulate-stipitate to infundibuliform; buff to off-white with brown, hazel to sienna warts (<1 mm) on flanks; margin is rimmed with short dense buff hairs; hymenium buff. Stipe 1-5 mm wide to 10 mm long; buff.

Micro-characters Ascospores 24-25 x 9.5-11 µm; broadly fusiform; verrucose.

Collections SMF0370, SMF0504, SMF1506, SMF1556

Images Asc370L, Asc504L, AsBWt1506La-b, AsWts1556La-b

Discomycete sp. C

This buff discomycete has pale warts and a short blunt stipe or the stipe is absent, which differs from the previous taxon.

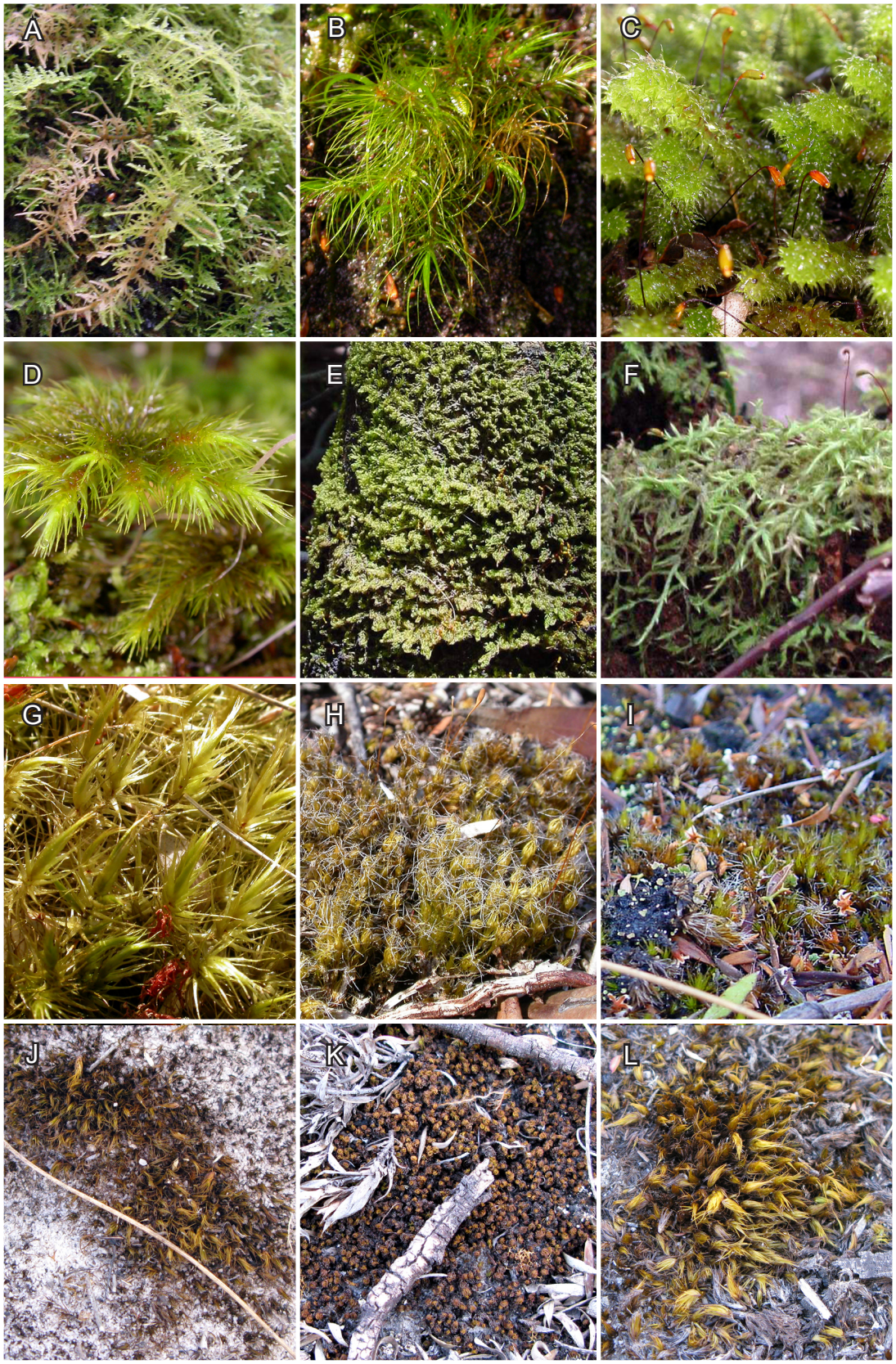


Figure 1. Mosses from wet forest (A-F), heathy woodlands (G-L). (A) *Thuidium sparsum,* (B) *Dicranoloma* sp., (C) *Ptychomnion aciculare,* (D) *Hypnodendron* sp., (E) Sematophyllaceae species, (F) *Wijkia extenuata,* (G) *Dicranoloma* sp. (H-I) *Campylopus* spp., and *Bryum* spp., (J) *Campylopus* spp. (K) *Tortula* sp., and (L) *Campylopus* spp.

Figure 2. Mosses from grassy woodlands (A-F) and alpine heath (G-L): (L) covered in frost. (A) *Weissia controversa*, (B) *Pottiaceae* spp., (C) *Ceratodon purpureus,* (D-F) *Breutelia* sp. (G) *Polytrichum* sp., (H) *Sphagnum* sp., (J) *Andreaea* sp. and *Campylopus* spp., (K) *Racomitrium* sp., and (L) *Polytrichum* sp.

Figure 3. Macrofungi. (A) Discomycete sp. B, (B) Discomycete sp. D, (C) Discomycete sp. E, (D) *Chlorociboria aeruginascens,* (E) Agaric sp. A, (F) *Agaricus* sp. A, (G) *Cystolepiota* sp. A, (H) *Lepiota* aff. *haemorrhagica,* (I) *Amanita* aff. *murinaster,* (J) *Amanita xanthocephala,* (K) *Coprinus* aff. *disseminatus,* and (L) *Entoloma viridomarginatum.* Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Figure 4. Macrofungi. (A) *Entoloma* sp. A, (B) *Entoloma* sp. B, (C) *Hygrocybe* aff. *minutula,* (D) *Hygrocybe* sp. A, (E) *Hygrophorus involutus,* (F) *Hypholoma fasciculare,* (G) *Collybia* aff. *eucalyptorum,* (H) *Gymnopus alkalivirens,* (I) *Marasmiellus affixus,* (J) *Mycena interrupta,* (K) *Mycena subgalericulata,* and (L) *Mycena viscidocruenta.* Scale in some images is a white tag (23 x 13 mm).

Figure 5. Macrofungi. (A) *Mycena* sp. A, (B) Tricholomataceae sp. B, (C) *Austroboletus* aff. *occidentalis,* (D) *Boletellus ananiceps,* (E) *Boletellus obscurecoccineus,* (F) *Fistulinella mollis,* (G) *Cantharellus concinnus,* (H) *Clavaria amoena,* (I) *Ramariopsis bicolor,* (J) *Ramariopsis pulchella,* (K) *Cortinarius* aff. *alboviolaceus,* and (L) *Cortinarius* sp. D. Scale in some images is a white tag (23 x 13 mm).

Figure 6. Macrofungi. (A) *Cortinarius* sp. E, (B) *Crepidotus eucalyptorum,* (C) *Descolea recedens,* (D) *Dermocybe austroveneta,* (E) *Gymnopilus allantopus,* (F) *Lentinellus pulvinulus-hepatotrichus,* (G) *Lactarius* aff. *sepiaceus,* (H) *Russula* aff. *cyanoxantha,* (I) *Punctularia strigosozonata,* (J) *Podoscypha petalodes,* (K) *Stereum hirsutum,* and (L) *Tremella* sp. A. Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Figure 2. Canopy cover (A - D) and wood (E - H) in different vegetation types: wet forest (A and E), heathy woodland (B and F), grassy woodland (C and G) and alpine heath (D and H).

Figure 4. Typical litter (A - D) and cryptogamic ground cover (E - H): burnt ground (G) in different vegetation types: wet forest (A and E), heathy woodland (B and F), grassy woodland (C and G) and alpine heath (D and H).

Macro-characters Apothecia 5-10 mm across to 8 mm deep; cupulate with narrow attachment, urceolate; buff to honey, with ample pale warts (<1 mm); hymenium buff. Stipe reduced or absent.

Micro-characters Ascospores 16-18.5 x 10-11.5 µm; ellipsoid; smooth. Paraphyses filiform.

Collections SMF0506, SMF1591

Images Asc506L, AsBWt1591La-c

Discomycete sp. D

This gregarious, irregularly shaped, dirty cream-coloured taxon was usually observed with abundant rhizoids which had a tendency to bind the litter together (Figure 1). Usually observed on eucalypt bark.

Macro-characters Apothecia 1-15 mm across to 10 mm deep; irregular cupulate with narrow attachment to tremelloid; dirty cream to pale grey. Stipe reduced with narrow attachment darker than rest of apothecia, dirty grey. Dark rhizoids present.

Micro-characters Ascospores 20-25 x 4.5-5 µm (x = 22 x 4.7 µm); narrowly fusiform, slightly curved with one end more pointed. Paraphyses filiform and aseptate.

Collections SMF0349, SMF1077, SMF1998

Images Asc349L, Asc1998Fa-b, Asc1998La-d

Figure 1. (A) Discomycete sp. A, (B) Discomycete sp. B , (C) Discomycete sp. D, (D) *Mollissia* aff. *cinerea,* (E) *Peziza* sp. A, (F) *Rutstroemia* sp. A, (G) *Xylaria* sp. A, (H) *Xylaria* sp. B, (I) Agaric sp. A, (J) *Agaricus* sp. A, (K) *Agaricus* sp. B, (L) *Agaricus* sp. C. Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Discomycete sp. E

This taxon was only found once. It had large, umber apothecia with a reduced stipe that had a purplish tint (Chapter 2: Figure 6). In cross section this taxon had a distinctly purplish-grey medullary excipulum.

Macro-characters Apothecia 25 mm across to 10 mm deep; infundibuliform with narrow attachment; flanks umber with warts (<1 mm); hymenium umber. Stipe reduced <2 mm; pale purplish grey. Medullary excipulum pale purplish-grey.

Micro-characters Ascus tip weakly blueing (Meltzers reagent). Paraphyses project above the asci.

Collections SMF1197

Images AsViol1197fa-b, AsViol1197L

Discomycete sp. F

This black discomycete was distinctive from other dark discomycetes like *Plectania campylospora* and *Rutstroemia* spp.

Macro-characters Apothecia 7-25 mm across to 5-8 mm deep; cup-shaped, black, rim irregular, outer surface warty. No stipe.

Micro-characters Ascospores 21-30 x 12-15 µm (x = 24.8 x 13.4 µm) ellipsoid, smooth. Asci with 8 uniseriate ascospores, tip not amyloid. Paraphyses narrowly cylindrical with subclavate apices (to 5.5 um). Ectal excipulum with short, thick-walled cylindrical hairs arising from layer of angular, rather short elements.

Collections SMF0371

Images Asc371L

Discomycete spp. I

This is a grouping based on similar morphology with all specimens pale discomyetes, found on woody substrates. There are probably a number of species in this group.

Collections SMF0501, SMF1077, SMF1314, SMF2032

Images Asc501L, AsPale1077L, Aspale1314F-b, Aspale1314La, Asco2032Fa-b

Discomycete spp. II

This was a group of taxa based on similar morphology, with all specimens having yellow to orange disks found on woody substrate. This group was separated from the terrestrial *Discinella terrestris* in the field on the basis of substrate. This common grouping may include rare observations of *Bisporella citrina* (Batsch) Korf & S.E. Carp. which is known from Tasmania (Gates and Ratkowsky 2005).

Collections	SMF1127, SMF1198, SMF1420, SMF2202
Images	AsOY1127L, AsYO1198fa-b, AsYO1198L, AscBi2202La-c

Discomycete spp. III

This group is based on having a yellow apothecium but is not one of the already described taxa. Many of these collections have more of a cup or vase shape rather than the yellow to orange disks described above. This is a very broad group and probably contains many species.

Collections	SMF0254, SMF0405, SMF0436, SMF0465, SMF0550, SMF1056, SMF1514
Images	Asc254L, AsBWts405L, Asc436L, Asc465L, Asc550L, Asc1056L, AsY1514La-b

Discomycete spp. IV

This orange taxon has apothecia that seem to be emerging from woody substrates, so may actually belong to Pyrenomycetes or Loculoascomycetes. There are probably at least three species in this group.

Collections	SMF0291, SMF0553, SMF1063, SMF1259, SMF1930, SMF2023
Images	AscOrPust553L, Asc1063L, AscOrPust1259L, AscPus1930Fa-b, AscPus1930La-b, Asc2023Fa-b, Asc2023La-b

Helotiales

Ascocoryne sarcoides (Jacq.) J.W. Groves & D.E. Wilson

This flesh to pale purple coloured fungus is distinctive as jelly-like irregular lumps or gelatinous cups to disks which are often found in clusters on wood. This is a Fungimap target species (Grey and Grey 2005). No voucher was retained.

Chlorociboria aeruginascens (Nylander) Kanouse complex

This turquoise cup (Chapter 2: Figure 6) matches the description in Breitenbach and Kranzlin (1984). Observations of this group need microscopic checking, as there are probably a number of turquoise taxa found in Tasmania, given there are a number of turquoise *Chlorociboria* in New Zealand (McKenzie *et al.* 2000).

Macro-characters Apothecia 3-6 mm diam. across; cupulate-stipitate; often irregular; turquoise.

Micro-characters Ascospores 6.5-8 x 1.5-2 width µm long (x = 7.4 x 1.8 µm); short clavate-cylindric; aseptate.

Collections SMF2272

Images AscTurq2272Fa, AscTurq2272La-b

Geoglossum aff. *glutinosum* Pers.

This dark earth-tongue matches the macrodescription of *Geoglossum glutinosum* in Spooner (1987) well, although apothecia were larger than suggested. This taxon is considered to have affinities with this named species due to differences in the microscopic characters. Spores are smaller and asci broader than expected, it and does not have narrow gelatinised hyphae on the stipe surface.

Macro-characters Fruit-body 2-5 mm diam. to 80 mm high; spathulate apex; black to dark brown; smooth; viscid papillose region between spathulate apex and smooth stipe.

Micro-characters Ascospores 59-60 x 6.5-8 µm; cylindric; 3-5 septate; some dark at maturity but most are unpigmented. Asci 14-17 µm. Paraphyses tip clavate to subcapitate apex; septate below apex; grey . Gelatinised hyphae on stipe surface not seen.

Collections SMF1488

Images AsGeo1488Fb-c, AsGeo1488La-b

Lachnum lachnoderma (Berk.) Hahn & Ayers

This commonly gregarious species stands out due to the pale, densely haired outer surface, with a distinct apricot centre. Characters observed from the collections fit the description in Spooner (1987).

Macro-characters Apothecia <1-4 mm across; short-stipitate; off-white with densely haired outer surface to the disc; hymenium apricot to pale orange. Stipe <1 mm to 1 mm long; central.

Micro-characters Ascospores 18-25 x 1.5-2 µm (x = 23 x 1.8 µm); narrowly fusiod; 1-sepatate.

Collections SMF0372, SMF0532

Images Lachlac372L, Asc532L

Leotia lubrica (Scop.) Pers.

This yellow to olive coloured ascomycete has a clear irregularly shaped 'cap', and a distinct stem. This is a Fungimap target species (Grey and Grey 2005).

Collections SMF1515

Torrendiella clelandii (Hansford) Spooner

These small, dark ascomycetes are common on leaf and twig litter. These collections match the description in Spooner (1987).

Macro-characters Apothecia 2-15 mm across to 15 mm deep; cupulate-stipitate; scattered to gregarious. Receptacle dark grey, olivacious-brown; margin dark hairs; hymenium off-yellow, grey, citrine. Stipe <1-3 mm to 10 mm long; dark grey, charcoal.

Micro-characters Ascospores 17-21 x 5.5-6.5 µm (x= 18.4 x 6 µm); ellipsoid-fusoid; hyaline; uniseriate. Setae dark brown with simple base.

Collections SMF0420, SMF0478, SMF0427, SMF1255, SMF1936, SMF1960, SMF1971

Images Asc1936Fa-c, Asc1936La-e, Asc1960La-c, Asc1971Fa-c, Asc1971La-d, Asc420L, Asc427L, AsYhair1255L

Torrediella eucalypti (Berk.) Spooner

This yellow-orange species is smaller than *T. clelandii* and is found on *Acacia* phyllodes. The collection matches the description in Spooner (1987).

Macro-characters Apothecia <1-1 mm diam. across; infundibuliform; orange to dull yellow.

Micro-characters Ascospores 16-17 x 3.5-4 µm; fusoid; hyaline.

Collections SMF2017

Images Asc2017Fa-b, Asc2017La-c

Pezizales

Aleuria rhenana Fuckel

The collection of this medium sized orange disk matches the description in Rifai (1968).

Macro-characters Apothecia 7-20 mm diam. across stipitate to substipitate to 7 mm long, exterior pale orange with fine warts, hymenium bright orange.

Micro-characters Ascospores 17-18 x 8-9 µm (x = 17.4 x 8.7 µm); inamyloid with reticulations, to approx. 1 µm high. Asci clyindric-clavate with an inamyloid pore, partially biserate to uniserate. Paraphyses filiform, enlarged towards apex, some with a hook at the apex.

Collections SMF0221

Discinella terrestris (Berk. & Broome) Dennis

This common orange discomycete on soil matches the description in Dennis (1958).

Macro-characters Apothecia 2-15 mm diam. across; discoid. Hymenium yellow, orange. Receptacle flanks pale orange-yellow. Stipe 2-4 mm to 5 mm long; narrow attachment.

Micro-characters Ascospores 14-16.5 x 6 µm; broadly fusoid; hyaline ; smooth. Asci apices have amyloid pore.

Collections SMF1901

Images AsDisTer1901Fa-b, AsDisTer1901La-b

Mollissia aff. *cinerea* (Batsch.: Fr.) P.Karst.

This irregular grey discomycete is gregarious and often caespitose (Figure 1). Characters match the macrodescription in Breitenbach and Kranzlin (1984), although individuals were up to 5 mm diam. across.

Macro-characters Apothecia <1-5 mm diam. to 3 mm high; irregular urceolate to pulvinate; pale to dark mouse grey. Stipe absent.

Collections	SMF1540, SMF2103
Images	AsLump1540Fa-b, AsLump1540La-b, Asc2103Fa-c, Asc2103La-d

Peziza sp. A

This larger brown *Peziza* had no stipe and the cup margin as finely warty (Figure 1). Microscopic checking is needed to separate this taxon from *Peziza* sp. B.

Macro-characters Apothecia 25-35 mm; discoid with broad attachment; honey, greyish sepia, hazel; hymenium smooth but with undulating surface; margin has fine concolorous warts. Stipe absent.

Micro-characters Ascospores 12-15 x 6.5-8 µm; ellipsoid to broadly ellipsoid; finely asperulate (Meltzers reagent); Ascus tip strongly blueing (Meltzers reagent). Asci 8-spored.

Collections	SMF0406, SMF0561, SMF1565
Images	AsBBu406L, AsBBu1565La-d

Peziza sp. B

Despite the similarity of the brown apothecia with fine warts on the margin to *Peiziza* sp. A, this taxon is distinctive from the previous one because it has a distinct narrow attachment and the spores are larger. Microscopic checking is needed to separate this taxon from *Peziza* sp. A.

Macro-characters Apothecia 28 mm diam. across; discoid with narrow attachment; pale ochraceous to hazel; fine concolours warts on margin. Stipe central narrow attachment.

Micro-characters Ascospores 18-21 x 10-11 µm; broadly ellipsoid; smooth; hyaline (Meltzers reagent). Ascus tip strongly blueing (Meltzers reagent).

Collections	SMF1483
Images	AsBBu1483La-d

Plectania campylospora (Berk.) Nannf.

This large, black cup grows on wood and has a wrinkled stem and the rim of the cup is rough. This distinctive fungus was recognised based on the macrocharacters. This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Apothecia 8-30 mm diam.; hymenium black with a black-brown rough margin. Stipe up to 25 mm long, 5-12 mm diam; deeply wrinkled and concolorous.

Collections SMF0412, SMF0500, SMF1509

Images Plec412L, Plec500L, Plec1509La-b

Pulvinula miltina (Berk.) Rifai

This brilliant scarlet species was only seen and collected once. It is easily recognised by the small bright scarlet disks without marginal hairs. Microcharacters agree with the description by Rifai (1968).

Macro-characters Apothecia 2-7 mm across, scarlet, with smooth exterior and no stipe.

Micro-characters Ascospores 14-17 µm (x = 15.9 µm); globose; smooth. Asci not amyloid, cylindrical, with 8 uniseriate ascospores, base abruptly contracted, and sometimes forked. Paraphyses filiform, apex projecting, strongly curved and enlarged a little (to 3 µm).

Collections SMF0387

Images Asc387L

Rutstroemia sp. A

This black discomycete (Figure 1) was distinctive from *Plectania campylospora* and Discomycete sp. F. It was found emerging from *Eucalyptus* logs.

Macro-characters Apothecia 2-8 mm diam.; cupulate-stipitate to funnel shaped; often irregular; dark grey to black, dries paler; hymenium concolorous, usually umbilicate. Stipe 4-8 mm long (lower portion in substrate), 1-4 mm diam.; tapering towards base; concolorous with apothecia.

Collections SMF1191

Images AsBl1191L

Xylariales

Xylaria sp. A

This large, hard taxon is antler-shaped with many irregular branches (Figure 1). This was much larger and branched than *Xylaria* sp. B described below. Specimens were recognised based on their macrocharacters.

Macro-characters Apothecia to 95 mm; branches 3-8 mm; grey with white powery surface. Stipe 5-10 mm diam. Across to 50 mm; velvety black.

Collections SMF1253

Images UkGAntlers1253La

Xylaria sp. B

This hard, bluntly clavate taxon was distinctive and had a white fertile surface with a black stipe (Figure 1).

Macro-characters Apothecia <1-3 mm diam., up to 10 mm high including 2-4 mm of black stipe; clavate to bluntly clavate; fertile surface white.

Collections SMF1595

Images XylariaUK1595Fa-c, XylariaUK1595La

Agaricales

Agaric sp. A

This taxon is pale with clearly decurrent gills and looks similar to *Hygrocybe rodwayi* (Figure 1). Microscopically, however, it has yellow-brown, amygdaliform, finely verrucose spores. This taxon does not fit neatly into any of the known genera, but as it has obvious gills it has been included under the Agaricales.

Macro-characters Pileus 10-15 mm diam.; funnel-shaped; cream; dry. Lamellae decurrent; close; cream. Stipe to 30 mm long, 2-4 mm diam.; tapers towards base; cream; dry.

Micro-characters Basidiospores 10-11 x 6 µm (x = 10.3 x 6 µm); amygdaliform; yellow-brown (KOH); finely verrucose, warts sparsely distributed.

Collections SMF1156

Images Ukdec1156f, UkDec1156L

Agaric spp. I

An *a priori* decision was made not to collect brown, gilled taxa unless there was a reasonable chance of identifying material at least to genus. This taxon is an assortment of usually poor-quality collections that were not identified to genus; many more such specimens were recorded as ‘brown mushrooms’ and not collected. This group no doubt contains such genera such as *Conocybe, Cortinarius, Galerina*, *Hypholoma, Panaeolus,* and *Psathyrella*.

Macro-characters Pileus brown. Lamellae brown. Stipe brown.
Collections SMF0253, SMF0326, SMF0385, SMF0386, SMF0435, SMF1064, SMF1424, SMF1462
Images PanB253L, BM326La-b, BM385L, BM385386L, BM386L, BM385386L, LBM435L, BM1064L

Agaricus sp. A

This typical looking *Agaricus* was present in wet forest (Figure 1). None of the collections matched the descriptions of species dealt with by Grgurinovic (1997). This is probably most distinctive from the lack of characters; it does not stain with handling, nor does it have a particularly distinctive size or shape.

Macro-characters Pileus 35-60 mm diam.; plane to concave; buff with dense umber scales, darker towards the centre. Lamellae free; crowded; rosy buff to sepia. Stipe to 65 mm long, 6-10 mm diam.; off white; annulus present and concolorous with stipe; with a slightly swollen base.

Micro-characters Basidiospores 5.5-5.75 x 3.25-3.5 µm (x = 5.5 x 3.3 µm); ellipsoid; yellow-brown (KOH); smooth. Cheilocystida common; ovoid to clavate.

Collections SMF1170
Images Ag1170L, Ag1170f

Agaricus sp. B

This robust *Agaricus* is distinctive because of the dense warm-brown scales on the cap and lower stem (Figure 1). This taxon has a particularly large and robust habit but did not match descriptions of species included in Grgurinovic (1997), so probably represents a single, undescribed taxon.

Macro-characters Pileus 40-70 mm diam.; young specimens truncate to parabolic, no mature specimens observed; warm dark brown, dark brick to sepia; dense furry scales. Lamellae free; crowded; buff becoming pink. Stipe to 95 mm long, 15-25 mm diam.; partial veil attached to pileus; off-white near gills with sepia furry scales on lower two thirds of stipe; stipe thickens towards base.

Micro-characters Basidiospores 5.5 x 3.25-3.5 µm (x = 5.5 x 3.3 µm); ellipsoid; yellow-brown (KOH); smooth. Cheilocystida common; ovoid to clavate.

Collections SMF1150
Images Ag1150L, Ag1150F-b

Agaricus sp. C

This small, buff, almost smooth-capped *Agaricus* becomes tinged with yellow when handled (Figure 1). The stem bruises yellow, but it is not *Agaricus xanthodermus* Genev., nor the other yellowing taxon described below. This is distinctive with its fine fibrils on the cap and ellipsoid to subglobose spores.

Macro-characters Pileus 35-40 mm diam.; plano-convex; buff becoming tinged with yellow after handling; fine radial fibrils of light brown colour; dry. Lamellae free; crowded; brown to dark chocolate brown. Stipe to 35 mm long, 3-6 mm diam.; appressed annulus; off white to buff; smooth texture; base yellows with handling.

Micro-characters Basidiospores 4.5-5.5 x 3.5-4.5 µm (x = 4.9 x 3.9 µm); ellipsoid to subglobase; thick walled; yellow-brown (KOH). Cheilocystidia present; 12-24 x 8-10 µm (x = 16 x 8.5 µm); ovoid to clavate; thin walled, hyaline (KOH); smooth.

Collections SMF2277

Images Ag2277Fa-c, Ag2277La-b

Agaricus spp. I

These have the appearance of a typical *Agaricus* with buff to brown fibrillose pileus and lamellae that mature from pale pink to chocolate brown. This group stains a yellow colour, particularly the stipe; this group includes collections similar to *Agaricus xanthodermus* Genev., but none of the collections fits this species in the strict sense.

Collections SMF1021

Images Ag1021F, Ag1021L

Anthracophyllum archeri (Berk.) Pegler

A distinctive orange to ochre gilled species that is typically laterally attached to woody substrates and with little to no stem. This is a Fungimap target species (Grey and Grey 2005). No voucher was retained.

Amanita griselloides D.A.Reid complex

This complex of larger grey *Amanita* has a distinctive membranous annulus. Within the collections there are two distinct taxa, which match *A. griseovelata* and *A. griselloides* as described by Wood (1997). These two taxa were not separated out in the field. The presence of a volva and the larger size separates the *Amanita griselloides* complex from the other grey *Amanita* (*Amanita* aff *murinaster*)..

Macro-characters Pileus 30-80 mm diam.; plane to plano-convex; smoke grey, greyish sepia, some darker specimens, with smoke grey patches. Lamellae free; close to crowded; off-white. Stipe 100 mm long, 5-15 mm diam.; greyish sepia, paler above the membranous annulus.

Collections SMF0122, SMF0127, SMF1238, SMF1241

Images Aman122Fa, Aman122La, Aman127Fa, Aman127La, Aman1238F-b, Aman1238L, Aman1241L

Amanita aff. *murinaster* A.E.Wood

This smaller grey *Amanita* represents a single taxon (Figure 2). It was distinctive from the other grey Amanitas as it was smaller and had a distinctive volva. This taxon keys out to *A. murinaster* in Wood (1997), but the described Q (1.12-1.17) is smaller than in the collection from the present study, so it has been considered a taxon with affinities to this species.

Macro-characters Pileus up to 42 mm diam.; plane to plano-convex; smoke grey to greyish sepia, with smoke grey, mealy veil remnants. Lamellae free; close to crowded; white. Stipe to 70 mm long, 7-12 mm diam.; white with a membranous annulus; volva at base.

Micro-characters Basidiospores 7-8.75 x 5.5-6.5 µm (x = 7.9 x 6 µm; Q = 1.30); broadly ellipsoid; amyloid; smooth. Basidia 4-spored; sub-basal cell inflated. Velar remains mainly of inflated spherical hyphae with some filamentous hyphae.

Collections SMF1286

Images Am1286Fa-b, Am1286La

Amanita xanthocephala (Berk.) D.A.Reid & R.N.Hilton

This distinctive orange *Amanita* (Chapter 2: Figure 6) matches the descriptions from Wood (1997) and Bougher and Syme (1998). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 20-38 mm diam.; plane, convex to slightly depressed; orange to red-orange; translucent striate; orange, lemon yellow to off-white veil remnants. Lamellae free; close; white to pale lemon yellow. Stipe up to 70 mm long, 4-15 mm diam.; pale lemon yellow to pale orange; volva with orange rim at base.

Micro-characters Basidiospores 7.75-10 x 6.5-8.75 µm (x = 8.6 x 7.4 µm; Q = 1.15); broadly ellipsoid to subglobose; inamyloid; smooth. Basidia 4-spored, sub-basal cells inflated. Marginal cells clavate. Velar remains with even amounts of inflated spherical and filamentous hyphae.

Collections SMF0120, SMF1517

Images Aman120Fa-b, Aman120La, Aman1517Fa-b, Aman1517La-b

Amanita sp. A

This cream to ochraceous-coloured *Amanita* has a membranous striate annulus, and does not match any of the species described by Wood (1997). This is likely to be a single undescribed taxon.

Macro-characters Pileus 60-90 mm diam.; plano-convex; pale yellow to off-white with powdery, sienna to peach veil remnants. Lamellae adnate; close; white. Spore print white. Stipe to 110-140 mm long, 12-17 mm diam.; ivory, with a peach flush from the annulus to base; annulus is membranous striate; with a minimal volva.

Micro-characters Basidiospores 8.5-10 x 6.5-8.75 µm (x = 9 x 7.7µm; Q = 1.16); subglobose to broadly ellipsoid; weakly amyloid; smooth. Velar remains are mainly filamentous hyphae with some clavate to spherical inflated hyphae (x = 40 x 29 µm).

Collections SMF0133

Bolbitius sp. A

This viscid brown-capped *Bolbitus* has pale gills that become ochraceous with maturity. This fits the genus concept in Grgurinovic (1997) and probably represents an undescribed taxon.

Macro-characters Pileus 12-20 mm diam.; plane to plano-depressed; umber to isabelline, becomes paler as it dries; viscid. Lamellae adnate; crowded; buff becoming ochraceous. Stipe up to 32 mm long, 2-3 mm diam.; white with fine silvery longitudinal fibrils.

Collections SMF1086, SMF1100

Images PlutBglutC1086La-b

Bovista sp. A

This puffball fits *Bovista* using the key in Grgurinovic (1997), but does not fit any of the included species well. This puffball has a very reduced stem, a central round mouth and the peridium becomes papery with age.

Macro-characters Fruit-body 12-25 mm diam.; subglobose; hazel to mustard brown; young specimens with fine granular surface (<1 mm diam.), becoming papery with maturity; mouth central, ragged. Gleba olive brown at maturity; reduced sterile base cellular, brown.

Micro-characters Basidiospores 4.5-5 x 4-5 µm (x = 4.7 x 4.3 µm); globose; finely verrucose; yellow-brown (KOH) with long pedicle (5-14 µm long). Capillitium yellow-brown; sparsely branched with ends very narrowly tapered; pores absent.

Collections SMF0209, SMF1049, SMF2219

Images Lyco209L, Puff2219Fa-c, Puff2219La-c

Figure 2. (A) *Amanita* aff. *murinaster,* (B) Clavariaceae sp. A, (C) *Campanella* sp. A, (D) *Collybia* aff. *eucalyptorum,* (E) *Coprinus* aff. *disseminatus,* (F) Cortinariaceae sp. A, (G) *Cortinarius* aff. *austroviolaceus,* (H) *Cortinarius fibrillosus,* (I) *Cortinarius aff. violaceus,* (J) *Cortinarius* sp. B, (K) *Cortinarius* sp. C (L) *Cortinarius* sp. D. Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Callistosporium sp. A

This bright scarlet gilled collybioid taxon is distinctive. Microscopically, collections had bright orange pigment in water mounts, which is one of the characters for *Callistosporium* in (Bas *et al.* 1995). This may be confused with red *Mycena*s, but there is a distinct opaqueness to the cap surface.

Macro-characters Pileus 5-12 mm diam.; convex, plano-convex; orange, red, scarlet, darker in centre red-rust; dry; opaque. Lamellae sinuate; close; scarlet, bright rust, apricot. Stipe upt to to 40 mm long, <1-2 mm diam.; red near lamellae darkening to rust, red-brown near base; tapers towards base.

Micro-characters Basidiospores 4.5 x 3-4.25 µm (x = 4.5 x 3.3 µm); broadly ellipsoid, obovoid, subglobose; pale orange (H_2O); smooth. Pileipellis of loose hyphae with occasional clavate terminal elements.

Collections SMF0356, SMF0502

Images Call0356F, Call0356L, Call0502L

Calyptella sp. A

This small white taxon is distinctive due to the absence of characters. It has no gills or stem and attaches directly to bark or woody substrates. This taxon matches the concept of the genus *Calyptella* in Singer (1986).

Macro-characters Pileus 1-2 mm diam.; half a parabolic cap; off-white to cream; dry; smooth. Lamellae absent. Stipe absent.

Micro-characters Basidiospores 7.25-8.25 x 4.5-5 µm (x = 7.8 x 4.5 µm); ellipsoid to broadly fusiform; hyaline; smooth. Cystidia narrowly conical. No gelatinised tissue seen in tissue of pileus.

Collections SMF1975

Images Calp1975Fa-b, Calp1975La-c

Campanella sp. A

This stemless eccentric grey taxon has distinctive anastomosing gills (Figure 2). This taxon is similar to *Campanella olivaceonigra* (E.Horak) T.W.May & A.E.Wood (May 1989), but does not have blue tints in the cap and has different shaped spores and infrequently capitate cheilocystidia.

Macro-characters Pileus 1-12 mm diam.; convex to hemispherical; attaching directly to substrate; grey to buff with olivacius tints; dry. Lamellae anastomosing; distant; pale grey. Stipe absent.

Micro-characters Basidiospores 9.5-11 x 5.25-5.5 µm (x = 10.3 x 5.4 µm); triangular-fusoid spores; hyaline; smooth. Cheilocystidia moniliform to flexuose, occasionally capitate at apex; not branched.

Collections SMF1566, SMF1977

Images Camp1566La-d, Camp1977Fa-b, Camp1977La-c

Clavaria amoena Zoll. & Moritzi complex

This simple club-shaped *Clavaria* (Chapter 2: Figure 8) had yellow, unbranched fruit-bodies. This complex may include several taxa (Petersen 1988).

Macro-characters Fruit-body up to 60 mm high, <1-4 mm diam.; simple clubs; yellow, opaque. Stipe indistinct; concolorous.

Collections SMF0257, SMF0265, SMF2012, SMF2013

Images ClavAm257L, ClavAm265L, ClavAm2012Fa, ClavAm2013Fa

Clavaria miniata Berk. complex

This usually simple club-shaped clavariod species has red to orange clubs. This complex may include several taxa (Petersen 1979).

Macro-characters Fruit-body up to 120 x 60 mm, 1-6 mm diam.; simple clubs, occasionally subsimple to very sparcely branched; red, scarlet to orange coloured; occasional branches near the tips. Stipe indistinct; concolorous to slightly paler.

Collections SMF1482

Images ClavMin1482Fa-d, ClavMin1482La-c

Clavaria spp. I

This was a group of taxa, which were simple clubs, white, off-white, cream to bone in colour, and with no distinctive odour. This group may contain a number of taxa.

Macro-characters Fruit-body up to 50 mm high, 1-5 mm diam.; simple clubs; clavate to fusiform; white, off-white, cream to bone. Stipe indistinct, concolorous.

Collections SMF0401, SMF0424,

Images Clavwhite401L, Clavwhite324L

Clavariaceae sp. A

This taxon despite being immature was very distinctive with white, flattened, simple branches.

Macro-characters Fruit-body to 90 mm high; branches flat with rounded tips; white to off-white towards base. Stipe indistinct; caespitose; off-white.

Micro-characters Basidiospores not seen. Basidia not seen. Trama clamps not seen.

Collections SMF1504

Images ClavWhite1504La-b

Clitocybe sp. A

This agaric with decurrent grey lamellae is similar to *Rhodocybe* spp. I (which also has distinctly decurrent lamellae) but differs by the opaque sheen and the white spore print. Collections were checked microscopically and did not have the polygonal spores of *Rhodocybe*, and so fit the concept of *Clitocybe* Singer (1986), but the Australian species are not well known.

Macro-characters Pileus 12-25 mm diam.; depressed; isabelline; smooth. Lamellae decurrent; close; smoke grey. Stipe up to 50 mm long, 2-5 mm diam.; isabelline; smooth.

Collections SMF1280

Images Clit1280F, Clit1280La

Collybia aff. *eucalyptorum* Cleland

This pale capped, darker stemmed *Collybia* taxon (Figure 2) matches the macro-description in Grgurinovic (1997) well, but no cheilocystidia were noted and spores

were at the smaller end of the range, so this is considered a single taxon with affinities to *Collybia eucalyptorum*. This species was recognised easily from the macrocharacters.

Macro-characters Pileus 35-50 mm diam.; plano-convex; straw, cream, buff at margin darkens to ochraceous buff in centre; smooth; dry. Lamellae close; straw. Stipe up to 110 mm long, 3-8 mm diam.; red-brown.

Micro-characters Basidiospores 5.5-6.5 x 3-3.75 µm (x = 6.2 x 3.4 µm); ellipsoid; hyaline ; smooth.

Collections SMF1302

Images Col1302F-c, Col1302L

Collybia sp. A

This taxon has pale yellow fruit-bodies, with a distinctively hemispherical cap which is translucent striate at the margin. This taxon fits the broad generic concept of *Collybia* in Singer (1986), but does not fit a known Australian species.

Macro-characters Pileus 7-14 mm diam.; hemispherical; pale yellow to primrose; smooth, translucent striate at margin. Lamellae decurrent; sub-distant; pale yellow. Stipe up to 25 mm long, 1-2 mm diam.; conclorous with pileus; basal tomentum present.

Micro-characters Basidiospores 7-9 x 3.25-4.5 µm (x = 8.3 x 3.9 µm); narrowly ellipsoid to navicate; smooth; spore mass has purple grey colour in Meltzers reagent but not amyloid; pale yellow-brown (KOH). Cheilocystidia common, 47-57 x 8-10 µm (x = 51 x 8.8 µm); narrowly conical, narrowly lageniform, narrowly fusiform, some with small capitate apex; thick walled. Pleurocystidia common and similar to cheilocystia. Pileipellis a mixture of cylindrical, frequently branched hyphae and very broad, occasionally branched hyphae. Clamps present in pileipellis.

Collections SMF1292, SMF1296

Images Col1292L, Col1296L

Collybia spp. I

This is an artifical grouping of all pale spored collybioid taxa (*Collybia sensu lato*) not described elsewhere in this section. Although there was morphological variation been the collections, each variant was only found once and may represent an undescribed taxon.

Collections SMF1303, SMF1356, SMF1981, SMF2034, SMF2035

Images Col1303F-c, Col1303La, Col1356Fa-b, Col1356FLa-b, Col1981Fa-b, Col1981La-d, Col2034Fa-c, Col2034La-b, Col2035Fa-b, Col2035La-b

Conocybe spp.

These small, brown mushrooms were lumped to genus in the field; this group probably contains a number of taxa.

Macro-characters Pileus 4-10 mm diam.; convex to hemispherical; ochraceous to cinnamon; hygrophanous; sometimes striate. Lamellae adnate to adnexed; close; ochraceous. Stipe up to 40 mm long, <1 mm diam.; cinnamon paler towards pileus; white basal mycelium.

Micro-characters Basidiospores ellipsoid with germ pore; thick-walled; yellow-brown; smooth. Stipitipellis with common lecythiform caulocystidia.

Collections SMF0321, SMF0432, SMF0505, SMF1052

Images Cono432L, Cono505L, Cono1052L

Coprinus aff. *disseminatus* (Pers. : Fr.) Gray

This plicate *Coprinus* is yellow when immature, becoming grey (Figure 2); this has affinities to the macrodescription of the cosmopolitan species *Coprinus disseminatus* (Grgurinovic 1997).

Macro-characters Pileus 5-20 mm diam.; convex to hemispherical, immature specimens parabolic; immature specimens straw yellow at margin to yellow as a distinct dot in the centre, mature specimens with yellow to ochraceous tints in centre; plicate; translucent at maturity. Lamellae adnexed; close; immature straw yellow, maturing to dark grey. Stipe up to 70 mm long, 1-3 mm diam.; off-white to pale yellow-brown at base.

Collections SMF2261

Images Cop2261Fa

Coprinus sp. A

This delicate translucent *Coprinus* has distinctive macrocharacters and may be an undescribed taxon.

Macro-characters Pileus 6-15 mm diam.; umbilicate, depressed, convex; sienna centre and along radial ridges, lavender-grey in the furrows; translucent.

Lamellae attached forming a collar; distant; black. Stipe up to 30 mm long, <1-1 mm diam.; white near lamellae, pale umber towards base; grey fibrils attached to base.

Collections SMF1025

Images Cop1025L

Cortinariaceae sp. A

This taxon has the appearance of an ochraceous *Omphalina* (Figure 2). The mature gills have a pink-buff colour, but unexpectedly the spores are finely verrucose, yellow brown and amygadaliform. These spores suggest that the taxon belongs in the Cortinaricaceae.

Macro-characters Pileus 4-14 mm diam.; umbilicate; ochraceous, opaque. Lamellae decurrent; distant; off-white in young specimens becoming pink-buff. Stipe up to 15 mm long, 1-3 mm diam.; ochraceous to dull yellow, some specimens have a green tint at the base; dry; smooth.

Micro-characters Basidiospores 10-11.25 x 5.25-5.5 µm (x = 10.8 x 5.4 µm); amygdaliform to narrowly fusiform, are adaxially flattened but no plage present; inamyloid; finely verrucose; yellow-brown (KOH). Pileipellls in scalp view has clavate to capiate terminal elements, which are deep yellow-brown, these arise from cylindrical hyphae which are strongly encrusted, slightly thick walled and have clamp connections.

Collections SMF2255

Images CortUK2255Fa-b, CortUK2255La-b

Cortinarius abnormis Watling & T.W.May

This glutinous, yellow-brown capped *Cortinarius* is distinctive as it has a relatively persistent cortina and bruises brown with handling. Collections match the description in Watling *et al.* (1992).

Macro-characters Pileus 10-45 mm diam.; convex, plano-convex, umbonate, conical in immature specimens; yellow, yellow-brown, sienna, fulvous, darker in centre; glutinous, less obvious in immature specimens; radially fibrillose in immature specimens; bruises brown.. Lamellae adnexed; close; buff. Stipe up to 70 mm long, 5-10 mm diam.; pale yellow to straw coloured near lamellae, lower two-thirds yellow covered with sienna cortina; yellow to sienna cortina in immature specimens; bruises brown. Flesh yellow.

Micro-characters Basidiospores 11-12.5 x 6.25-7.75 µm (x = 11.7 x 7.3 µm); amygdaliform with acute apex; yellow-brown (KOH); verrucose, sparse on apex.

Collections SMF1162, SMF1260

Images CortY1162fa-b, CortY1162L, CortYGl1260L

Cortinarius aff. *alboviolaceus* (Pers. : Fr.) Fr.

This pale shapely *Cortinarius* is distinctive (Chapter 2: Figure 8) by having violacious tints and viscid beads on the pileus and stem. The macrocharacters match those in Fuhrer (2005).

Macro-characters Pileus 18-35 mm diam.; convex, plano-convex with inrolled margin; off-white with greyish lilac tints; viscid cap with beads of glutin. Lamellae adnexed to sinuate; close; buff to pale purplish grey. Stipe up to 90 mm long, 4-12 mm diam.; off-white with greyish lilac tints, discolours pale yellow with handeling; viscid beads of gluten, particularly near lamellae; thickens towards base. Flesh yellow to primrose.

Micro-characters Basidiospores 9-10.5 x 5-5.75 µm (x = 9.6 x 5.3 µm); narrowly ellipsoid to narrowly amygdaliform, at time apex acute; pale yellow-brown (KOH); finely verrucose.

Collections SMF1129, SMF1161

Images Cortalbov1129L, CortalbV1161fa-d, CortalbV1161L

Cortinarius archeri Berk.

This large, purple, very glutinous taxon is distinct as it is also has a glutinous cortina. The collection matches the description in Bougher and Syme (1998), although the spores are slightly small than their average.

Macro-characters Pileus 60-180 mm diam.; convex, plano-convex; umber to brown with violacious tints, immature specimens purple to violet; very glutinous. Lamellae adnate; close; buff with violacious tints. Stipe up to 90 mm long, 12-35 mm diam.; off-white and dry above cortina, greyish violet glutinous cortina covering lower two-thirds; base swollen. Spore print ochraceous rust.

Micro-characters Basidiospores 11-13 x 6.5-7 µm (x = 12.2 x 6.8 µm); amygdaliform to elongate-ellipsoid; yellow-brown (KOH); verrucose. Cheilocystidia present; narrowly clavate.

Collections SMF1192

Images CortArcheri1192Fa, CortArcheri1192L

Cortinarius aff. *austroviolaceus* B.Gasparini

This dark violet taxon is very similar to *Cortinarius* aff. *violaceus* described below (Figure 2). These two taxa are probably part of a complex in Australia which needs more work to determine the scope of species. This taxon was smaller and dark purple with only the gills black with violet tints and was microscopically most similar to the description of *Cortinarius austroviolaceus* in Gasparini (2001).

Macro-characters Pileus 6-25 mm diam.; convex, hemispherical; dark violet drying to dark purple; dry; radial silky fibres are nearly black. Lamellae adnexed; close; black with violet tints. Stipe up to 60 mm long, 5-10 mm diam.; dark purple to violet with nearly black fibrils longitudinally along stipe; dense pruple cortina covers whole stipe in immature specimens; some bases spindle shaped. Flesh pale chalky purple near base and in pileus, dark purple near lamellae and centre of stipe. Spore print ochraceous rust.

Micro-characters Basidiospores 7.75-10 x 5-5.75 µm (x = 9 x 5.5 µm); amygadaliform; yellow brown (KOH); finely verrucose. Cheilocystidia abundant; 50-63 x 8-10 µm; fusiform to lecythiform, capitate cheilocystidia common; contain purple pigment (KOH). Pleurocystidia not seen.

Collections SMF2262

Images Cort2262Fa-b, Cort2262La-b

C*ortinarius fibrillosus* Cleland

This smaller cinnamon-coloured *Cortinarius* has an obviously fibrillose cap (Figure 2). The collections match the description in Grgurinovic (1997), under the name *Inocybe fibrillosa*.

Macro-characters Pileus 5-20 mm diam.; convex, umbonate, parabolic; cinnamon, rusty-brown, paler at margin; younger specimens densely fibrillose with buff to pale cinnamon, mature specimens sparsely fibrillose. Lamellae adnexed, sinuate; close; ochraceous to yellow-brown. Stipe up to 80 mm long, 1-4 mm diam.; immature specimens covered with off-white fibrillose often sheathing veil, mature specimens pale ochraceous to cinnamon coloured with off-white fibrils common along stipe, most densely covered at the base.

Micro-characters Basidiospores 6.5-8.5 x 3.75-4.75 µm; ellipsoid; pale yellow-brown (KOH); smooth to finely verrucose, particularly at the apex.

Cheilocystidia abundant; shortly clavate, ovoid, subglobose, or globose; thin-walled. Pileipellis hyphae thick walled.

Collections SMF0200, SMF0222, SMF0380, SMF2000

Images Cort0200L, Cort0380L, Cort2000Fa-b, Cort2000La

Cortinarius rotundisporus Cleland & Cheel

This distinctive *Cortinarius* has viscid cap with a distinctive metallic blue colour and a pale stem. Characters of the collection match the description in Bougher and Syme (1998) and is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 15-45 mm diam.; umbonate, convex in immaure specimens; pale metallic blue at margin, centre ochraceous, immature specimens deep blue; viscid, to dry. Lamellae sinuate; close; lavender-grey. Stipe up to 80 mm long, 5-20 mm diam.; pale lavender grey near lamellae, these tints continue below, buff to off-white on lower two-thirds; longitudinally fibrillose; tapers towards lamellae. Spore print ochraceous rust.

Micro-characters Basidiospores 7-8 x 5.5-6.25 µm (x = 7.4 x 5.8 µm); subglobose; yellow-brown (KOH); verrucose.

Collections SMF0141

Cortinarius aff. *violaceus* (L. : Fr.) Gray.

This dark violet taxa is very similar to *Cortinarius* aff. *austroviolaceus* described above (Figure 2). This collection was larger and darker, nearly black in older specimens and microscopically most similar to the description of *Cortinarius violaceus* in Bougher and Syme (1998).

Macro-characters Pileus 50-85 mm diam.; plane, depressed; violacious black to violet slate, blak in older specimens; dry; radially fibrilose. Lamellae sinuate; crowded; black. Stipe up to 50 mm long, 10-20 mm diam.; purple slate to livid violet with longitudinal fibrils; dark cortina mid-stipe. Flesh purple slate. Spore print ochraceous rust.

Micro-characters Basidiospores 11-13 x 6-6.5 µm (x = 11.8 x 6.3 µm); amygdaliform, some with suprahilar plage; yellow brown (KOH); finely verrucose. Cheilocystidia abundant; 99 x 18 µm; fusiform to conical; brown tint (KOH). Pleurocystida present and similar to cheilocystidia.

Collections SMF1416

Images CortAustV1416L-b

Cortinarius sp. B

This single collection is distinctive despite being a small brown *Cortinarius* as it has a particularly mycenoid habit (Figure 2). This might be confused with a large *Conocybe* but has no ring and had fine fibrils on the stem, as well as verrucose spores.

Macro-characters Pileus 4-18 mm diam.; papillate to umbonate; fulvous to ochraceous; translucent striate. Lamellae adnate; sub-distant; ochraceous. Stipe up to 45 mm long, <1-2 mm diam.; fulvous; scattered minute longitudinal fibrils.

Micro-characters Basidiospores 6-6.5 x 4-5 µm (x = 6.3 x 4.5 µm); broadly ellipsoid; finely verrucose; no plage; yellow-brown (KOH). Chilocystidia scattered, narrowly utriform. Pileipellis repent cylindric hyphae with brown encrusting pigment.

Collections SMF1520

Images Cort1520Fa-b, Cort1520La-b

Cortinarius sp. C

This is a distinctive *Cortinarius* as it has lilac tints in the universal veil, so immature specimens are mainly lilac-grey which contrasts with mature specimens which are predominantly dull yellow (Figure 2). This is a single, as yet undescribed taxon.

Macro-characters Pileus 15-110 mm diam.; convex, plano-convex; immature specimens are greyish lavender with pale yellow tints, mature specimens are pale yellow with sienna tinted fibrils; dry. Lamellae adnexed; close; pale yellow with ochraceous tints. Stipe up to 95 mm long, 10-20 mm diam.; greyish lavander near lamellae, amber below; fulvous fibrils longitudinally arranged; bublbous base, to 30 mm diam.; lilac tints. Basal mycelium is cream coloured.

Micro-characters Basidiospores 8-9.25 x 4.5-5.5 µm (x = 8.8 x 5 µm); amygdaliform with acute apex in side view; yellow-brown (KOH); finely verrucose.

Collections SMF1083

Images CortYP1083L

Cortinarius sp. D

This *Cortinarius* is distinct as is lavender coloured with a rosy vinaceous tint with no hint of brown across the whole fruit-body (Figure 2). This taxon is distinct from the

other purple taxa described here and it also does not match the description of *Cortinarius lavandulensis* (Bougher and Syme 1998).

Macro-characters Pileus 20-50 mm diam.; umbonate, depressed; lavander to pale violet at margin to off-white in centre with violet tints; some specimens glutinous. Lamellae sinuate; close; rosy vinacious. Stipe up to 70 mm long, 8-15 mm diam.; lavander, pale violet with rosy vinacious tints; longitudinally fibrillose; dry; slightly swollen at base.

Micro-characters Basidiospores 8.25-9 x 5.5-5.75 µm (x = 8.7 x 5.5 µm); amygdaliform, ellipsoid; yellow brown (KOH); sparcely finely verrucose.

Collections SMF1333

Images Cort1333Fa-b

Cortinarius sp. E

This large, creamy, pale ochraceous *Cortinarius* (Figure 3), does not match described pale species like *C. australiensis* and *C. sublargus* (Grgurinovic 1997), so probably represents a undescribed taxon.

Macro-characters Pileus 60-140 mm diam.; plano-convex, convex; cream, off-white, pale ochraceous; dry. Lamellae slightly decurrent; close; buff to off-white. Stipe up to 150 mm long, 12-30 mm diam.; white, ivory, off-white; pale longitudinal fibrils, covered with spore deposits; base spindle shaped, caespitose. Spore print ochraceous rust.

Micro-characters Basidiospores 7.25-8 x 3.75-4.5 µm (x = 7.6 x 4.1 µm); amygdaliform; yellow brown (KOH); medium verrucose.

Collections SMF2275

Images Cort2275Fa-f, Cort2275La-d

Cortinarius spp. I

This is a sub-group of brown *Cortinarius* that were grouped together as they all had dry cap surfaces and pale stems. There are a few taxa in this group, some with sheathing veil remnants, some without.

Collections SMF0195, SMF1422, SMF1423, SMF0383, SMF0394, SMF0509, SMF1164, SMF1257, SMF2016, SMF0458, SMF0463, SMF1236, SMF1342, SMF1900, SMF2016

Images Cort0195L, Cort383L, Cort0394L, Cort0458L, Cort0463L , Cort0509L, Cort1164fa-b, Cort1164L,

	Cort1236F, Cort1236L, Cort1257L, Cort1342Fa-b, Cort1900Fa-c, Cort1900La-b, Cort2016Fa-b, Cort2016La-b

Cortinarius spp. II

This is a grouping of the *Cortinarius* that have a dry cap and purple tints to the cap and or the stem. This group does not include *Cortinarius* aff. *austroviolaceus* or *Cortinarius* aff. *violaceus*. This group probably contains a number of related, currently undescribed taxa.

Collections	SMF1092, SMF1095, SMF1281, SMF1295
Images	Cort1092L, Cort1095L, Cort1281Fa-c, Cort1281La, Cort1295L

Cortinarius spp. III

This is a group of *Cortinarius* which have purple tints to the cap and stem, the cap is also glutinous and becomes brown with maturity. This group excludes *Cortinarius archeri* and *C. rotundisporus*. This is probably a small group of related, currently undescribed taxa.

Collections	SMF0355, SMF1338, SMF1341, SMF2237, SMF2256
Images	Cort0355F, Cort0355L, Cort1338Fa-b, Cort1341Fa-b, Cort2237Fa, Cort2237La-c, Cort2256Fa-b, Cort2256La-c

Cortinarius spp. IV

This is a grouping of all the brown *Cortinarius* not already described above. This is a large group containing many undescribed taxa, some of which may belong in *Dermocybe*.

Collections	SMF0110, SMF0230, SMF0256, SMF0258, SMF0259, SMF0260, SMF0293, SMF0330, SMF0352, SMF0381, SMF0388, SMF0452, SMF0490, SMF1110, SMF1146, SMF1194, SMF1230, SMF1237, SMF1252, SMF1258, SMF1340, SMF1415, SMF1421, SMF1432, SMF1481, SMF2001
Images	Cort0256L, Cort0258L, Cort0259L, Cort260L, Cort0330L, Cort0352L, Cort0381L, Cort0388L,

Cort0452L, Cort0490L, Cort1110L, Cort1146F, Cort1146L, Cort1194fa-b, Cort1194L, Cort1230F, Cort1230L, Cort1237F, Cort1237L Cort1252L, Cort1258La-b, Cort1340Fa-b, Cort1415L,, Cort1481Fa-c, Cort1481La-d, Cort2001Fa, Cort2001La

Crepidotus eucalyptorum Cleland

This laterally attached ochraceous species (Chapter 2: Figure 9) has a woolly texture to the cap surface, and no stem, rather it attaches by fluffy mycelium to the substrate. Collections match the description in Grgurinovic (1997).

Macro-characters Pileus 2-50mm diam.; convex, flabelliform; off-white to buff in immature specimens, mature specimens ochraceous, pale umber; woolly to fibrisosely scaly. Lamellae close; buff, ochraceous. Stipe not definate, attaches by fluffy mycelium.

Micro-characters Basidiospores 8-10.5 x 5.75-7.25 µm (x = 10.5 x 7.1 µm); ellipsoid, slightly thick-walled; yellow-brown (KOH); smooth. Cheilocystidia abundant, forming a sterile edge; 35-60 x 5-11 µm (x = 45 x 8 µm); cylindric.

Collections SMF1094, SMF2236

Images Crep1094L, Crep2236Fa-c, Crep2236La-e

Crepidotus aff. *nephrodes* (Berk. & M.A.Curtis) Sacc.

This laterally attached species sometimes has a reduced stem, unlike *Crepidotus nephrodes* (Grgurinovic 1997), which has no stipe. However, the rest of the characters fit, so it is considered a single taxon with affinies to *Crepidotus nephrodes*. This taxon can be separated from the previous species by being paler and nearly smooth to finely villose in texture.

Macro-characters Pileus 15-30 mm diam.; lateral attachment with reduced stipe, convex, flabelliform; buff, honey, ochros, pale yellow-brown; nearly smooth to finely villose. Lamellae close; buff to off-white. Stipe absent or reduced.

Micro-characters Basidiospores 6.5-7.75 x 5.5-7.25 µm (x = 7 x 6.5 µm); globose to subglobose; yellow-brown (KOH); spinulose. Cheilocystida present; clavate.

Collections SMF0353, SMF0477, SMF1965

Images Crep353L, Crep477L, Crep1965Fa-d, Crep1965La-b

Crinipellis sp. A

This is a distinctive taxon in *Crinipellis*, with long setiform, dextrinoid hairs on the cap surface. It fits the desciption of this genus in Bas *et al.* (1995). This taxon may be confused with *Marasmius* spp. but on close inspection of the cap it has fine hairs present (Figure 3).

Macro-characters Pileus 2-10 mm diam.; plano-convex with papilla to umbonate; straw, buff, with sienna tints darkening the centre umbo and along radial grooves; coarse hairs radially arranged; margin scalloped, often with pale ciliate fringe. Lamellae adnexed, adnate; subdistant; white. Stipe up to 17 mm, <1-1 mm diam.; tawny brown, buff near lamellae; longitudinally fibrillose.

Micro-characters Basidiospores 7.5-9 x 4.5-6 µm; ellipsoid or slightly trianagular; hyaline ; inamyloid; smooth. Cheilocystidia branching, often digitate. Pileipellis of long, thick-walled, dextrinoid hairs.

Collections	SMF2221, SMF2222, SMF2223
Images	Crin2221Fa-b, Crin2221La-c, Crin2222Fa-b, Crin2222La-b, Crin2223Fa-f, Crin2223La-b

Cystoderma muscicola (Cleland) Grgur.

The apricot colour of the fruit-bodies stands out against the green moss in which it grows. Both macro and micro-characters fit those described by Grgurinovic (1997), although specimens were slightly larger.

Macro-characters Pileus 23-32 mm diam.; convex; apricot to pale umber; opaque. Lamellae adnate; subdistant; off-white. Stipe up to 40 mm long, 3-6 mm diam.; tough; umber; pale floccose veil on stipe.

Micro-characters Basidiospores 6-8.2 x 3.3-4.4 µm (x = 7.1 x 4.1 µm); elliptical; amyloid; smooth. Basidia 4-spored.

Collections	SMF0165
Images	CystMusc165L

Figure 3. (A) *Cortinarius* sp. E (B) *Crinipellis* sp. A, (C) *Descolea* sp. A, (D) *Dermocybe austroveneta,* (E) *Entoloma* sp. B, (F) *Gymnopilus allantopus,* (G) *Gloiocephala* sp. A, H) *Hygrocybe* aff. *minutula,* (I) *Hygrocybe* sp. A, (J) *Hygrocybe* sp. B, (K) *Hygrotrama* sp. A, (L) *Lepiota aff. haemorrhagica.* Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Cystolepiota sp. A

The delicate fruit-body (Chapter 2: Figure 6) has an opaque off-white to buff cap and stem. This is probably a single undescribed taxon.

Macro-characters Pileus 3-10 mm diam.; convex, plano-convex; off-white to buff in the centre; opaque; immature specimens have white appendiculate veil remnants. Lamellae free; close; white. Stipe to 35 mm long, <1-2 mm diam.; white below lamellae, red-brown with a vinacous tint on the lower two-thirds.

Micro-characters Basidiospores 5.25-6.5 x 2.75-3.25 µm (x = 6 x 3 µm); ellipsoid; dextrinoid, hyaline (KOH); smooth.

Collections SMF0457, SMF1201

Images Cystolep457L, Cystolep1201Fa-c, Cystolep1201L

Descolea recedens (Cooke & Massee) Singer

This small robust brown mushroom (Chapter 2: Figure 9) has a distinctive striate annulus. These collections match the description in Grgurinovic (1997).

Macro-characters Pileus 14-25 mm diam.; plano-convex, convex, umbonate; ochraceous near margin becoming fulvous to umber in the centre, striate at margin; dry; covered with ochraceous patches to grains. Lamellae adnexed, adnate; close; sometimes margin rough; buff, ochraceous. Stipe up to 45 mm long, 2-8 mm diam.; buff near lamellae darkening to ochraceous, yellow-brown below annulus; tapers towards lamellae. Annulus distinct, reflexed, striate above.

Micro-characters Basidiospores 10-13 x 5.5-8 µm (x = 11.7 x 6.9 µm); amygdaliform, stronely mucronate; yellow-brown (KOH); finely verrucose, sparse at apex. Cheilocystidia not seen.

Collections SMF1536, SMF1903, SMF2005, SMF2230

Images Desc1536La-e, Desc1903Fa-b, Desc2005Fa-b, Desc2005La-b, Desc2230Fa-b, Desc2230La-d

Descolea sp. A

This taxon certainly belongs in *Descolea* (Horak 1971) due to the rough spores and capitate cystidia. It differs from *Descolea recedens* by the longer stipe and pale

annulus (Figure 3), although the spores are the same size and shape. Further analysis is needed to establish if *Descolea* sp. A matches known species or not.

Macro-characters Pileus 9-30 mm diam.; umbondate, convex; chestnut, umber, dark brick; smooth, translucent striate at margin. Lamellae adnate, free; close; ochraceous to cinnamon. Stipe up to 50 mm long, 1-3 mm diam.; buff near lamellae, darkening to sepia below the annulus; longitudinal fibrils. Annulus fragile, pale cinnamon.

Micro-characters Basidiospores 11-13 x 7-8 µm (x = 11.6 x 7.2 µm); amygdaliform with mucronate apex; yellow-brown (KOH); finely verrucose. Cheilocystidia lecythiform.

Collections SMF1256, SMF1513

Images Desc1513Fa-b, Desc1513La-b

Dermocybe austroveneta (Cleland) M.M.Moser & E.Horak

This *Dermocybe* has a distinctive green cap, yellow gills and stem. It may vary in size and colour but always has a yellow colour in the gills and stem (Figure 3). Collections match the description in Grgurinovic (1997), although spores are smaller than the average. This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 7-40 mm diam.; convex, campanulate, plano-covex, in immature specimens may be parabolic; green, olive green, darker in the centre; dry; fine silky radial fibrils. Lamellae adnate; close; bright yellow. Stipe up to 80 mm long, 4-12 mm diam.; pale, bright yellow with longitudinal fibrils; distinct yellow cortina in immature specimens; some bases slightly swollen. Basal mycelieum yellow. Spore print ochraceous rust. Flesh bright pale yellow.

Micro-characters Basidiospores 8.25-9.5 x 5-5.5 µm (x = 9 x 5.3 µm); ellipsoid, amygdaliform; yellow-brown (KOH); verrucose.

Collections SMF2263

Images DermAV2263Fa, DermAV2263La-c

Dermocybe clelandii (A.H.Sm.) Grgur. complex

This brown capped *Dermocybe* is distinctive as it always has yellow gills and brown bands (cortina remnants) on the stipe. Care needs to be taken to separate this complex from brown *Cortinarius* which have yellow tints in the gills and stem. Collections match the description in Grgurinovic (1997), although spores were smaller than described, so this is consider a species complex.

Macro-characters Pileus 6-45 mm diam.; umbonate, convex, plano-convex, depressed with umbo; brown, umber, hazel, ochraceous; dry; fine silky radial fibrils. Lamellae sinuate, adnexed, adnate; close; amber, mustard yellow. Stipe up to 85 mm long, 2-12 mm diam.; paler near lamellae, pale yellow, amber, honey, pale ochraceous, darker towards base amber, ochraceous, hazel, umber; fulvous to umber bands 2-3, at times basal third sheathed; tapers towards lamellae.

Micro-characters Basidiospores 9-10 x 6.25-7 µm (x = 9.6 x 6.6 µm); ellipsoid to amygdaliform; yellow-brown (KOH); verrucose to corarsely verrucose.

Collections SMF0251, SMF0267, SMF0273, SMF1232, SMF1291, SMF1410, SMF1521, SMF2036

Images Cort251L, Cort267L, Cort273L, CortMust1232L, CortBGl1291L, Cort1410L, Cort1521Fa-b, Cort1521La-b, Cort2036Fa-c, Cort2036La-b

Dermocybe sp. A

This delicate olive coloured *Dermocybe* is similar to *Dermocybe austroveneta*, which may be olive green, but differs in the smaller stature and there are distinct olive tints in the stem; the spores are also smaller. This seems to be an undescribed taxon.

Macro-characters Pileus 6-25 mm diam.; umbonate, campanulate, papillate; olive to olive green, becoming more yellow towards the margin; dry; fine silky radial fibrils. Lamellae adnate to sinuate; close; amber with olive tints. Stipe up to 50 mm long, 1-8 mm diam.; pale yellow to buff near lamellae, olive to olive brown lower two-thirds; scallered brwon cortina remains along stipe. Basal mycelium pale yellow.

Micro-characters Basidiospores 6.5-8 x 3.5-4.75 µm (x = 7.3 x 4.4 µm); amygdaliform; yellow-brown (KOH); verrucose.

Collections SMF0271, SMF1502, SMF2010

Images Derm0271L, Derm1502La-b, Derm2010Fa

Entoloma panniculum (Berk.) Sacc.

This blue *Entoloma* has a distinctive livid to greyish violet colour and livid scales on the pileus and stipe. This matches the description of *Entoloma strictum* in Horak (1973), which was then synonymised with *Entoloma panniculum* by Horak (1980a). Collections fit the described spore size and pileipellis terminal elements contain brown pigment in KOH as per the description, but the terminal cells range from

mostly clavate to some fusiod or conically tapering, which differs from the description which indicates only conically tapering terminal cells.

Macro-characters Pileus 13-23 mm diam.; convex; dark livid, violet slate, greyish violet; fine livid scales. Lamellae adnexed; close; off-white with rosy-buff tint. Stipe up to 45 mm long, 3-4 mm diam.; dark livid, livid violet, violet slate with similar coloured scales; white tomentum at base.

Micro-characters Basidiospores 10 x 7 µm; angular; hyaline; smooth. Pileipellis of terminal elements containing brown pigment (KOH); mostly clavate with some being fusoid or conically tapering.

Collections SMF1040, SMF1283

Images EntoPrus1040L, EntoPrus1283Fa-b, EntoBl1283Lb

Entoloma viridomarginatum (Cleland) E.Horak

This green *Entoloma* has distinctive green emarginate gills (Chapter 2: Figure 6) and the collection matches the description in Grgurinovic (1997).

Macro-characters Pileus 8-25 mm diam.; hemispherical to depressed; green, olive-grey with yellow mottling; finely fibrillose, particularly in centre. Lamellae adnexed to sinuate; close; salmon-coloured with green margin. Stipe up to 30 mm long, 2-7 mm diam.; dark green lower two-thirds becoming pale green to yellow near lamellae; white tomentum at base.

Micro-characters Basidiospores 8-11 x 6.5-7 µm (x = 9.5 x 6.6 µm); angular, with 5-angles; hyaline; smooth. Cheiliocystidia present, cylindric to narrowly clavate.

Collections SMF0212, SMF1244

Images Entvirid212L, Entvirid1244L

Entoloma sp. A

This yellow gilled tricholomatoid taxon (Chapter 2: Figure 7) is an *Entoloma* as it has polygonal spores. It looks similar to the *Porpoloma* described below, as both have yellow gills, but this taxon has no obvious veil remnants.

Macro-characters Pileus 50-100 mm diam.; umbonate to plano-umbonate; honey to olivaceous buff; smooth, dry. Lamellae free; close; primrose to pale yellow. Stipe up to 11 mm long, 12-16 mm diam.; bright amber near lamellae, primrose lower three quarters, immature specimen has pale greenish-grey stipe; longitudinal fibres.

Micro-characters Basidiospores 7.75-9 x 6.5-7.75 µm (x = 8.4 x 7.1 µm); polygonal; inamyloid; hyaline.

Collections SMF1332

Images Ento1332Fa-b

Entoloma sp. B

This black capped *Entoloma* was a single collection so has been treated as an individual taxon. There are probably a number of black *Entoloma* species in Tasmania.

Macro-characters Pileus 10 mm diam.; convex; charcoal black; finely velvety. Lamellae close; pale pink. Stipe up to 20 mm long, 1-2 mm diam.; steel grey; white basal tomentum.

Collections SMF1902

Images EntBl1902fa-c, EntBl1902La-b

Entoloma spp. I

This is a large, artificial grouping of *Entoloma* collections that exhibited numerous shades of brown and grey. This is a catch-all group and does not include taxa that are described elsewhere in the appendix. This group includes two collections from Tasmania's alpine environment (SMF1032, SMF1033), referred to in McMullan-Fisher *et al.* (2003). These were distinct from the brown *Rhodocybe* spp. I and *Rhodocybe* spp. II described below.

Macro-characters Pileus usually <30 mm diam.; campanulate, umbonate to depressed with umbo; hygrophanous and translucent striate at margin; umber to hazel brown, darker in centre. Lamellae adnexed to sinuate; close; hazel brown with vinacous buff tints. Spore print vinacous buff.

Collections SMF0196, SMF0213, SMF0269, SMF0270, SMF0272, SMF1032, SMF1033, SMF1088, SMF1111, SMF1116, SMF1134, SMF1144, SMF1145, SMF1155, SMF1163, SMF1167, SMF1233, SMF1290, SMF1330, SMF1331, SMF1339, SMF1411, SMF1413, SMF1425, SMF1471, SMF2100, SMF2240

Images Ent196L, Ent213L, Ent269L, Ent270L, Ent272L, EntoAlp1033L, EntoIsab1088L, Entopaq1111L, EntGrS1116L, EntIsab1134L, Ent11441145F, Ent11451144L, Ent11451144L, Entisa1155f-b, Ent1155L, Ent1163L, Ent1167L, EntoIsab1233L, Entisa1290L, EntIsa1330Fa-b, EntHaz1331Fa-b, EntHaz1339Fa-b, EntGr1411L, Ent1413L, Ent2100Fa-b, Ent2100La-e, Ento2240La-c

Galerina muscolignosa A.E.Wood complex

The collection matches the description of both the macro-and micro-characters in (Wood 2001) for *Galerina muscolignosa*. This is considered a complex of taxa as the macro-characters alone do not seem to distinguish it from *Galerina neocalyptrata* and *Galerina subcerina* in the key provided by Wood (2001).

Macro-characters Pileus 2-7 mm; hemisporeical to conical; smooth, translucent striate at margin; carmel brown to ochraceous. Lamellae adnate; close; brown. Stipe 1-2 mm To 50 mm; smooth; carmel brown near gills darkening to red-brown near base.

Micro-characters Basidiospores 10.5-11 x 5.5-6.5 µm (x = 10.8 x 6.1 µm); ellipsoid, with plage; thickwalled but for apex; yellow-brown (congo red); finely rough. Cheilocystidia common; 41-55 x 8-14 µm (x = 48.2 x 11.4 µm); narrowly fusiform to narrowly lageniform.

Collections SMF0124

Images GalHyp124Fa, GalHyp124La

Galerina patagonica Singer *sensu stricto*

This species is the largest species among *Galerina*, and is further distinctive by the presence of a ring. The collections match the description in Wood (2001).

Macro-characters Pileus 13-23 mm diam.; umbonate; hygrophanous, translucent striate at margin; Amber, sienna to fulvous. Lamellae adnate to slightly decurrent; close; buff to ochraceous. Spore print brown. Stipe up to 50 mm long, 3-4 mm diam.; light ring near lamellae; ochraceous near lamellae darkening to fulvous to umber near base; ochraceous fine fribrils.

Micro-characters Basidiospores 8.5-10 x 4.5-6.5 µm (x = 9.5 x 5.6 µm); ellipsoid to amgdaliform; distinct marginal rim around suprahilar plage; yellow-brown (congo red), inamyloid; finely verrucose. Basidia 4-spored. Cheilocystidia common; 48-71 x 14-17 µm (x = 57.7 x 15.6 µm); ventricose-rostrate, lageniform to fusiform, apex simple to several short digitate processes. Pleurocystidia similar to cheiocystidia. Pileipellis filamentous; yellow-brown , thin-walled, inflated hyphae irregularly arranged.

Collections SMF0396, SMF0392, SMF1518, SMF2007,

Images Gal0392L, Gal0396L, Gal1518Fa-b, Gal1518La-b, Gal2007Fa, Gal2007La

Galerina aff. *patagonica* Singer

This taxon was similar to *Galerina patagonica* but differred in the smaller fruit-body that was more caramel in colour. In addition, it differed microscopically in that the cheilocystidia were most commonly subglobose to clavate, occasionally utriform, and the basidiospores were narrower on average than in collections of *G. patagonica*. This taxon is not described in Wood (2001), and may represent an undescribed taxon, perhaps with affinities to *G. patagonica*.

Macro-characters Pileus 20-25 mm diam.; umbonate; ochraceous to carmel brown; smooth. Lamellae adnate to slightly decurrent; close; buff to ochraceous. Stipe up to 30 mm long, 2-4 mm diam.; dark brown veil remnant near lamellae; ochraceous near gills darkening to fulvous to umber near base.

Micro-characters Basidiospores 8.25-9 x 4.5-5 µm (x = 8.7 x 4.7 µm); ellipsoid to amgdaliform; suprahilar plage present; yellow-brown (congo red), inamyloid; finely verrucose. Basidia 4-spored. Cheilocystidia common; 40 x 18 µm; broadly clavate; thin-walled. Pleurocystidia not seen. Pileipellis filamentous.

Collections SMF1251

Images Gal1251L

Galerina spp. I

This group was used when specimens did not look like the other Galerinas covered in this appendix but the specimens were of poor quality. Among the collections that were madethere is at least one taxon that is not described in Wood (2001).

Collections SMF0306, SMF0384

Images Gal384L

Gymnopilus allantopus (Berk.) Pegler

This large *Gymnopilus* is easily recognised by the white longitudinal fibrils covering the lower 4/5ths of the stipe (Figure 3). Collections match the description in Rees and Strid (2001).

Macro-characters Pileus 18-50 mm diam.; convex to hemispherical, campanulate; fine raidial fibrils, white veil remnants at margin; fulvous to ochraceous in centre paling to pale yellow at margin. Lamellae sinuate; close; bright yellow becoming ochraceous with age. Stipe up to 75 mm long, 4-9 mm diam.; white longidtudional veil remnants on lower three-quarters; pale yellow to buff near lamellae, darking to tan at base.

Micro-characters Basidiospores 8.25-9 x 5-6 µm (x = 8.6 x 5.5 µm); ellipsoid to amygdaliform, some subfusiform; yellow-brown; finely verrucose, some with plage. Cheilocystidia common; 25-30 x 5-6 µm (x = 25.2 x 5.3 µm); narrowlly lageniform, often containing yellow pigment. Pleurocystidia present; utriform, often containing yellow pigment.

Collections	SMF1084, SMF1089, SMF2265
Images	GymnBY1084F, GymnBY1084L, Gymn1089L, Gymn2265Fa-c, Gymn2265La-b

Gymnopilus eucalyptorum (Cleland) Singer complex

This group is made up of a number of *Gymnopilus* and *Galerina* taxa that are small and have bright margins, they are also often eccentric. These are difficult to distinguish apart in the field. At lease four taxa were collected based on the micro-characters. The taxonomy of this group has been covered by Rees *et al.* (1999)

Collections	SMF0480, SMF1980, SMF1090, SMF2243
Images	Gymn408L, Gym1980Fa-b, Gym1980La-c, GymnoEuc1090L, Gymn2243Fa-c, Gymn2243La-d

Gymnopilus ferruginosus B.J.Rees

This large rusty coloured *Gymnopilus* matched the description in Rees and Strid (2001). This is macroscopically similar to *G. moabus* described below, so collections need to be checked microscopically.

Macro-characters Pileus 22-65 mm diam.; convex to plano-convex; fine brown radially arranged scales; orange brown in centre, paling to bright orange at margin. Lamellae close; pale yellow. Stipe up to 100 mm long, 3-8 mm diam.; brown longitudinal fibres; tan near gills darkening to brown near base.

Micro-characters Basidiospores 7.5-9 x 5-6 µm (x = 8.5 x 5.4 µm); amygdaliform, with suprahilar plage; yellow-brown; roughly verrucose. Cheilocystidia common; 21-25 x 5-8 µm (x = 23.5 x 6.2 µm); lecythiform to lageniform with capitate apex; most contain yellow pigment . Pleurocystidia common; similar to cheilocystidia.

Collections SMF1061, SMF1315, SMF2030, SMF2270

Images GymnOr1315L, Gymn2030Fa-d, Gymn2030La-c, Gymn2270Fa-c, Gymn2270La

Gymnopilus junonius (Fr. : Fr.) P.D.Orton

This huge *Gymnopilus* is easily recognised by the size. Collections match description in Rees and Strid (2001). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 13-80 mm diam.; convex; fulvous to pale yellow scales scattered yellow to amber surface. Lamellae adnate to sinuous; close; pale yellow to ochraceous. Stipe up to 80 mm long, 7-25 mm diam.; disinct annulus, with ochraceous to fulvous fibrils over amber coloured stipe. Flesh pale yellow to amber.

Micro-characters Basidiospores 9.5-12.5 x 4.5-6.5 µm (x = 10 x 5.7 µm); ellipsoid with suprahilar plage; verrucose to roughly verrucose. Cheilocystidia abundant; 33-60 x 6-8 µm (x = 44.2 x 6.8 µm); fusiod to venricose with capitate apex.

Collections SMF1550

Images Gymn1550Fa-c, Gymn1550La-c, SMF1550Ma

Gymnopilus moabus Grgur.

This rust to sienna coloured *Gymnopilus* may be confused with *Gymnopilus ferruginosus* so collections need to be checked microsopically. Collections generally matched the descriptions in Grgurinovic (1997) and Rees *et al.* (1999); the macro-description fits particularly well. This collection had two size classes of the basidiospores, which if taken together fit the spore range given by (Grgurinovic 1997) better than that given by (Rees *et al.* 1999).

Macro-characters Pileus 18-35 mm diam.; convex to planoconvex; splits at margin; sienna to rust coloured. Lamellae sinuate; close; yellow to buff coloured. Stipe up to 30 mm long, 3-6 mm diam.; longitudinally striate; sienna coloured.

Micro-characters Basidiospores two size classes 7.5-8 x 5-5.5 µm (x = 7.6 x 5.1 µm) for most common size class and 9.25-11.5 x 6.5-7 µm (x = 10.4 x 7 µm); ellipsoid to broadly subfusiform; suprahilar plage present; yellow-brown; roughly verrucose. Cheilocystidia common, forming a sterile edge; 32-42 x 5 µm (x = 36 x 5 µm); lecythiform to fusiform with wide capitellum, some braching with two capitella.

Collections SMF1218

Images Gymno1218L

Gloiocephala sp. A

These tiny (cap 1-5 mm diam.) mycenoid mushrooms had a pale bullate cap and dark stem (Figure 3). This looks like a small *Mycena* or *Marasmius* but is distinct microscopically by having a getalinous context and having capitate cystidia on the lamellae edge, pileipellis and stipitipellis. This taxon is likely to be a single undescribed species. The genus has yet to be formally recorded from Australia.

Macro-characters Pileus 1-8 mm diam.; hemispherical; buff, ochraceous to off-white, translucent striate. Lamellae adnate; off-white; distant. Stipe up to 10 mm long, < 1 mm diam.; chestnut to fuscous black for most of the length, off-white just near lamellae.

Micro-characters Basidiospores 10-12.5 x 4.25-4.5 µm (x = 11 x 4.45 µm); subfusiform; hyaline ; smooth. Cheilocystidia common; 40-57 x 5–8 µm (x = 48.8 x 6.4 µm); narrowly fusiform to cylindrical with capitate apex. Gelatinous context present.

Collections SMF0348, SMF0415, SMF1401, SMF1402

Images Gloio1401F-b, Gloio1402F-b, Gloio1402L-b

Gymnopus alkalivirens (Singer) Halling

This is a distinctive maroon-coloured collybioid taxon (Chapter 2: Figure 7) and the collection matches the description in Halling (2004).

Macro-characters Pileus 15-35 mm diam.; plano-convex, to convex with depressed centre; maroon, dark vinacious to brown-vinacious; smooth. Lamellae adnexed; close; concolorous to slightly paler. Stipe concolorous with pileus.

Micro-characters Basidiospores 6.5-7.25 x 4-4.5 µm (x = 6.7 x 4.1 µm); ellipsoid to broadly ellipsoid; hyaline ; weakly amyloid; smooth.

Collections SMF1355

Images Gym1355Fa-b

Hebeloma sp. A

This taxon had a pale brown fruit-body with a viscid cap and pinky-brown gills. These characters are typical for the genus *Hebeloma* but the collection did not fit any of the species described in Grgurinovic (1997). This taxon was found once.

Macro-characters Pileus up to 35 mm diam.; plano-convex; fawn, buff to cream, with cinnamon patches where specimen was handled; viscid. Lamellae adnexed; pink to fawn; crowded. Stipe up to 45 mm long, 6-8 mm diam.; off-white with cinnamon to red-brown veil remnants long lower 2/3rds; base slightly swollen.

Micro-characters Basidiospores amygdaliform; pale yellow-brown; verrucose. Cheilocystidia abundant; ventricose with a narrow neck.

Collections SMF1297

Images Heb1297L

Hohenbuehelia bingarra Grgur.

This small pleurotoid taxon was collected once. Unfortunately the collection was meagre and is not suitable to lodge as a voucher. The characters of the collection matched those given in Grgurinovic (1997).

Macro-characters Pileus 3-15 mm diam.; laterally attached; isabelline; gelatinous texture. Lamellae off-white; decurrent.

Micro-characters Basidiospores 6.5-8 x 3.75-4.5 µm (x = 7.1 x 4 µm); ellipsoid, phaseoliform, allantoid; hyaline ; smooth. Cheliolocystidia lecythiform, thin-walled. Pleurocystidia metudoid, thick walled with encrusted apices. Pileiplellis interwoven brown hyphae with fusoid thick walled pileocystidia present; gelatinous layer below.

Collections SMF1211

Images UkHoenB1211L

Hohenbuehelia aff. *clelandii* Grgur.

This pleurotoid brown taxon has a small but reduced stipe. This fits the macrodescription in Grgurinovic (1997) but the spores are smaller than those described, so it is considered here as a single taxon with affinities to *Hohenbuehelia clelandii*.

Macro-characters Pileus 5-55 mm diam.;pleuritoid, eccentric; umber, pale umber to pale tan near margins. Lamellae Decurrent; close; cream to off-white. Stipe reduced, lateral; up to 15 mm long, 4-12 mm diam.; buff, cream; off-white; white basal tomentum.

Micro-characters Basidiospores 6.5-7 x 3.5-4 µm (x = 6.7 x 4.7 µm); ellipsoid; hyaline ; smooth. Cheilocystidia thin-walled; lecythiform, capitate, sometimes birfurcate. Pleurocystidia metuloid. Pileocystidia scattered; thick-walled; fusoid.

Collections SMF2020, SMF2021, SMF2241

Images Pleur2020Fa-b, Pleur2020La-c, Pleur2021La-c, Pleur2241Fa-b, Pleur2241La-d

Hygrocybe astatogala (R.Heim) Heinem.

This red, orange, and yellow, conical *Hygrocybe* becomes black with age. This is a distinctive species and matches the description in Young and Wood (1997).

Macro-characters Pileus 6-15 mm diam.; conical; red to orange with black and white veil remains covering whole fruit-body. Lamellae immature; orange with yellow margin. Stipe white to orange, with black veil remains.

Micro-characters Specimen immature, no spores observed.

Collections SMF1119

Hygrocybe cantharellus (Schwein. : Fr.) Murrill

This species may be distinguished macroscopically from other dry red taxa, such as *Hygrocybe miniata,* by the pale, strongly decurrent gills and the pileus with a distinctly crenulate margin. Microscopically larger spores are more common and the cap cuticle best matches the description of *Hygrocybe cantharellus* (Young and Wood 1997).

Macro-characters Pileus 5-10 mm diam.; convex; scarlet with orange fleecy scales in centre; striate margin; dry. Lamellae decurrent; distant; thick; off-white to

pale yellow. Stipe up to 20 mm long, 2-3 mm diam.; scarlet; dry; tapering towards base.

Micro-characters Basidiospores 7-10 x 5-6.5 µm (x = 8.8 x 5.8 µm); ellipsoid; hyaline ; smooth. Basidia 4-spored common, with occasional 2-spored basida present.

Collections SMF0217

Images HygrR217L

Hygrocybe chlorophana (Fr. : Fr.) Wünsche

These red to orange-yellow mushrooms were often darkened and deformed as the specimens emerged from the vegetation layer. Collections match the description of *Hygrocybe flavescens* in Young and Wood (1997), that according to Young (2000b) is a synonym of *H. chlorophana*.

Macro-characters Pileus 3-31 mm diam.; conical to convex; brown to darker towards centre, red to orange-yellow near margin, viscid when fresh. Lamellae adnate to free; sub-distant; thick; pale yellow-orange. Stipe up to 31 mm long; bright yellow; slightly viscid to dry; some with white basal mycelium.

Micro-characters Basidiospores 9.9-12.6 x 4.4-6 µm (x = 10.2 x 5.1 µm); oblong to ellipsoid; inamyloid; smooth. Basidia 4-spored. Pileipellis of interwoven filamentous hyphae, gelatinous layer present.

Collections SMF164, SMF1631, SMF1920

Images Hyg1920La-b

Hygrocybe graminicolor (E.Horak) T.W.May & A.E.Wood

This green, very gelatinous *Hygrocybe* dries to an orange, ochraceous colour and is macroscopically distinctive and matches the description in Young and Wood (1997). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 3-35 mm diam.; convex, centrally depressed to omphaloid; green to blueish green, becomes ochraceous to pale orange as it dries; gelatinous to sticky. Lamellae decurrent; close; thick; white; margin may be gelatinous. Stipe 5-45 mm long, 2-5 mm diam.; pale green to pale yellow to ochre at base; gelatinous to glutinous.

Collections SMF0144, SMF0225, SMF0268

Images HygrGram144La, HygrGram268Lb

Hygrocybe miniata (Fr. : Fr) P.Kumm.

This dry red *Hygrocybe* is macroscopically similar to *Hygrocybe cantharellus*, but may be distinguished by the pink tint to the gills, which are less obviously decurrent. This taxon matches the description in Young and Wood (1997).

Macro-characters Pileus 5-35 mm diam.; convex with depressed centre, margin may be slightly scalloped; scarlet to red-orange; fine squamulose at centre, hygrophanous, dry. Lamellae sinuate to decurrent; close; thick; yellow-red to pink-orange. Stipe up to 65 mm long, 2-6 mm diam.; scarlet, red-orange to peach, paler towards base; dry; tapers towards base.

Micro-characters Basidiospores 7-9.5 x 4.5-6 µm (x = 8.3 x 5.3 µm); ellipsoid; hyaline; smooth. Pileipellis of repent hyphae with no indication of gelatinisation.

Collections SMF0142, SMF0226

Images HygrR142La

Hygrocybe aff. *minutula* (Peck) Murrill

This viscid red *Hygrocybe* may be distinguished from the other taxa by both the cap and stipe being viscid to glutinous and the gills having a strong orange-yellow colour (Figure 3). The macrodescription and the spores match the description well in Young and Wood (1997). This species was not recorded from Tasmania by Young and Mills (2002), so this has been considered a taxon with strong affinities with *Hygrocybe minutula*.

Macro-characters Pileus 18-60 mm diam.; parabolic, plano-convex, some depressed; orange to scarlet; viscid to glutinous. Lamellae adnate; sub-distant, some interveined; thick and viscid; orange-yellow to apricot, yellow at margin. Stipe up to 75 mm long, 5-12 mm diam.; yellow to yellow-orange; viscid to glutinous.

Micro-characters Basidiospores 7-8.5 x 4.5-5 µm (x = 7.9 x 4.8 µm); broadly ellipsoid to subglobose; hyaline , smooth. Pileipellis is a disorganised ixocutis, not ixotrichoderm.

Collections SMF1489

Images HygrRed1489Fa-c, HygrRed1489La-b

Hygrocybe aff*. pratensis* (Pers. : Fr.) Murrill

This decurrent yellowish taxon was collected from heath, where specimens often have begun to dry out when found, as this collection was. This collection matches

the description of a drying *Hygrocybe pratensis* in Young, Bougher & Robinson (2000), microscopic characters fit the range but the average spore dimensions are nearly a full micron different so this taxon is considered to have strong affinities with *Hygrocybe pratensis*.

Macro-characters Pileus 8-35 mm diam.; convex, some depressed; pale yellow to straw; hygrophanous; dry. Lamellae decurrent; sub-distant; thick; pale yellow. Stipe up to 20 mm long, 4-6 mm diam.; straw; dry; slightly eccentric and narrows towards base.

Micro-characters Basidiospores 5.5-6.75 x 4-4.5 µm (x = 6 x 4.2 µm); broadly ellipsoid to subglobose; hyaline , smooth. Basidia have basal clamp connection.

Collections SMF0197

Images Hyg197L

Hygrocybe rodwayi (Massee) A.M.Young

This dry, pale decurrent *Hygrocybe* was distinctive from the other pale decurrent taxa. It often has dirty brown tints in the cap centre, also having no yellow or orange tints. This species was separated from the macroscopically similar *Hygrocybe virginea* by the smaller spores. Collections matched the description in Young and Wood (1997).

Macro-characters Pileus 10-40 mm diam.; convex with some depressed or plane at the centre; off-white to cream, pale grey to buff in centre; dry. Lamellae decurrent; sub-distant; cream to off-white. Stipe up to 45 mm long, 2-8 mm diam.; concolorous; dry; tapers towards base.

Micro-characters Basidiospores 5.5-7 x 4.5-6 µm (x = 6.4 x 5.2 µm); subglobose; hyaline ; smooth.

Collections SMF0389, SMF0393, SMF2104

Images Hyg389L, UkDecur393L, Hyg2104Fa-c, Hyg2104La-b

Hygrocybe sp. A

This green taxon does not fit *H. aurantipes, H. arcohastata, H. pseudograminicolor* or *H. taekeri* described (Young and Wood 1997; Young 2000a; Young and Mills 2002). As such it is probably an undecribed taxon (Figure 3).

Macro-characters Pileus 22-40 mm diam.; hemispherical, parabaloid, plano-convex; olive-green to karki; viscid. Lamellae sub-distant; thick; apricot to yellow.

Stipe up to 80 mm long, 4-8 mm diam.; orange-yellow to lemon yellow with slight green tint, paler towards lamellae; slightly viscid; tapers towards base.

Micro-characters Basidiospores 6.5-7.5 x 4-4.5 µm (x = 7 x 4.1 µm); ellipsoid; hyaline; smooth. Pileipellis of narrow, cylindrical hyphae (2.5-4 µm diam.), repent, clamps present.

Collections SMF1486

Images HygrGrOr1486Fa-f, HygrGrOr1486La-e

Hygrocybe sp. B

This orange capped *Hygrocybe* at first glance may be mistaken for *Cantharellus cinereus* var. *australis*, as it is also strongly decurrent and of a similar size (Figure 3). However, this taxon has a strong orange cap and the stipe is paler. This taxon does not match species descriptions any of the current Australian literature for *Hygrocybe* (Young and Wood 1997; Young 1999; Young 2000a; Young 2000c; Young *et al.* 2000; Young 2001a; Young 2001b; Young 2002; Young and Mills 2002).

Macro-characters Pileus 3-18 mm diam.; umbonate, campanulate, convex, conical; margin often inrolled; orange to yellow; smooth; dry. Lamellae decurrent; distant; thick; off-white to pale yellow. Stipe up to 75 mm long, 1-4 mm diam.; pale orange, salmon to off-white; dry; tapers towards base.

Micro-characters Basidiospores 6.5-8 x 4-4.75 µm (x = 7.3 x 4.4 µm); lacrymoid to pip-shaped; hyaline ; smooth; inamyloid. Basidia have basal clamp connection.

Collections SMF0407, SMF0411, SMF0462, SMF1212, SMF1501, SMF1516

Images Hyg407L, Hyg411L, Hyg462L, Hyg1212L, Hyg1501Fa, Hyg1501La-b, Hyg1516Fa-b, Hyg1516La-b

Hygrophorus involutus G.Stev.

This pale species (Chapter 2: Figure 7) has apricot tints that become stronger with time and handling. This collection matches the description in Young and Wood (1997).

Macro-characters Pileus 10-45 mm diam.; convex, plano-convex, plane; pale yellow to cream with apricot tints; viscid with droplets when fresh. Lamellae

adnate; close; bright pale yellow with apricot tint. Stipe up to 80 mm long, 2-8 mm diam.; concolorous with pileus; slightly viscid with droplets; tapers towards base.

Micro-characters Basidiospores 6.5-8 x 4-4.5 µm (x = 7.4 x 4.2 µm); broadly ellipsoid; hyaline ; smooth.

Collections SMF1470

Images HygrInv1470Fa-c, HygrInv1470La-d

Hygrotrama sp. A

This brown taxon was distinctive by the decurrent gills, khaki tint, and the long stem which tapers towards the base (Figure 3). This taxon clearly belongs to *Hygrotrama* Singer (1986) but Australian species are not well known.

Macro-characters Pileus 7-10 mm diam.; hemispherical, campanulate to depressed; khaki to hazel; fine radial scales; dry. Lamellae decurrent; distant; thick; buff to rosy-buff. Stipe up to 60 mm long, 1-4 mm diam.; pale yellow to khaki near lamellae to hazel on lower two thirds; tapers towards base.

Micro-characters Basidiospores 5.5-6 x 4.5-5.25 µm (x = 5.7 x 4.8 µm); subglobose to broadly ellipsoid; hyaline ; smooth.

Collections SMF1500, SMF1510, SMF1964

Images Hygrot403L, Hygrot1500Fa-b, Hygrot1500La-b, Hygrot1510La,

Hypholoma fasciculare (Huds. : Fr.) P.Kumm.

This species has clusters of yellow-orange fruit-bodies (Chapter 2: Figure 7) with vivid coloured gills that range from yellow, yellow-green, to orange. The gills may become darker with age as this is a dark-spored species. This species was recognised based on the macrocharacters.

Macro-characters Pileus 7-30 mm diam.; convex to plano-convex; dry; yellow-orange, burnt orange, darker towards the centre; fine white radial fibrils present on many specimens. Lamellae adnate; close; yellow to yellow-orange, some dark with spores. Stipe up to 100 mm long, 3-7 mm diam.; yellow to burnt orange, some specimens with fine white fibrils; dark brown ring of spores near lamellae in mature specimens.

Collections SMF2268

Images Hyph2268Fa-d, Hyph2268La-b

Inocybe australiensis Cleland & Cheel

This brown fibrillose capped *Inocybe* has a distinct red-brown stem. Collections match the description in Grgurinovic (1997).

Macro-characters Pileus 7-18 mm diam.; pappilate to plano-convex; hazel to ochraceous with dark red-brown radial hairs concetrated in the centre of the cap. Lamellae adnexed to sinuate; close; ochraceous to hazel. Stipe up to 35 mm long, 1-2 mm diam.; red-brown, fawn, dark red-brown; with scattered fibrils.

Micro-characters Basidiospores 8.25-10 x 5-6 µm (x = 9 x 5.4 µm); ellipsoid, subfusiform, amygdaliform; pale yellow-brown; smooth. Cheilocystida abundant; 40-65 x 10-16 µm (x = 53 x 13 µm); cylindrico-ventricose, metuloid; thick walled with encrusted apex. Pleurocystidia similar to chielocystida.

Collections SMF0481, SMF1200, SMF1285

Images InoA0481L, InoA481L, InoA1200fa-b, InoA 1200L, InoA 1285Fa-b, InoA1285L

Inocybe dewrangia complex

This brown bristle capped *Inocybe* fits the description of several taxa in Grgurinovic (1997), and as smell was not noted it has been considered a species complex. This taxon is distinct from the *Inocybe* sp. recorded in McMullan-Fisher *et al.* (2003), which has not been described here as it was not collected from around Hobart.

Macro-characters Pileus 12-20 mm diam.; convex, with broad umbo; umber to greyish sepia; dense radial bristles. Lamellae adnate; close; vinacious buff to buff. Stipe up to 20 mm long, 3-5 mm diam.; pale greyish sepia to umber from lamellae to base; longituionally fibrous; tapers towards lamellae.

Micro-characters Basidiospores 11-13 x 8-8.75 µm (x = 11.7 x 8.2 µm); nodulose with hemipsherical lumps; yellow-brown. Cheilocystitida and pleurocystidia scattered; metuloid, cylindro-ventricose; thick-walled with encrusted apex.

Collections SMF1600

Images InoBr1600Fa-b, InoBr1600La-e

Laccaria lateritia Malençon

This *Laccaria* usually has darker gills, that are more a glaucous red-brick colour than *Laccaria* sp. B. The collection matches description in Bougher and Syme (1998).

Macro-characters Pileus 6-25 mm diam.; hemispherical, plano-convex, umbonate; red-brown to orange-brown, hygrophanous; translucent striate at margin.

Lamellae adnate; close; red-brown with white chalky sheen. Stipe up to 55 mm long, 3-6 mm diam.; red-brown with pale longitudinal fibrils; broader at base, with the end being off-white coloured.

Micro-characters Basidiospores globose; hyaline ; sparsely spiny. Basidia 2-spored.

Collections SMF1966

Images Lac1966Fa-b, Lac1966La-b

Laccaria sp. B

This *Laccaria* has paler gills than *L. lateritia* described above. The collections are a good fit with the description in Grgurinovic (1997).

Macro-characters Pileus 8-15 mm diam.; hemispherical to convex; hygrophanous; red-brown, to brick, dries to saffron. Lamellae adnate; close; pale pink. Stipe up to 30 mm long, 2-3 mm diam.; red-brown to brick; longitudinally fibrillose; white basal tomentum.

Micro-characters Basidiospores 7.5-9.5 x 5.5-7.7 µm (x = 8.6 x 7.1 µm); subglobose, broadly ellipsoid, ellipsoid; hyaline ; spiny. Basidia 3-, 4-spored. Cheilocystidia filiform, often with lobed apices. Caulocystidia 27-50 x 10-17 µm (x = 37 x 12 µm); clavate, cylindric, capitate.

Collections SMF0204, SMF0231, SMF0250, SMF0262, SMF0307, SMF1632

Images Lac204L, LaccPale231L, Lac250L, Lac262L, LaccAlp1632L

Lepiota aff. *fuliginosa* Cleland

This grey to brown *Lepiota* is similar to the macrodescription of *Lepiota fuliginosa* in Grgurinovic (1997). The microscopic characters do not fit as well, so this taxon is treated as a single taxon with affinities to *Lepiota fuliginosa*.

Macro-characters Pileus 6-24 mm diam.; plano-convex, plane, convex; pale grey, smoke grey, buff, paler towards margin; dense, radially appressed, grey to brown scales. Lamellae free; close; white to off-white. Stipe to 25 mm long, 1-4 mm diam.; off-white near lamellae, buff below; scattered, fine, flattened scales near base; delicate free annulus usually present.

Micro-characters Basidiospores 5.5-7.5 x 3.25-4.75 µm (x = 6.4 x 3.8 µm); ovoid, ellipsoid; hyaline (KOH), dextrinoid; smooth. Cheilocystidia common; 26-30 x

8-9 µm (x = 27 x 8.6 µm); narrowly clavate, cylindrical, utriform. Pileipellis of interwoven hyphae with brown tint (KOH) with raised terminal elements.

Collections SMF0210, SMF0252, SMF1113, SMF1142

Images Lep210L, Lep252L, Lep1113L, Lep1142F

Lepiota aff. *haemorrhagica* Cleland

This red-brown *Lepiotia* bruises red when handled (Figure 3). Specimens have affinities with the macrodescription of *Lepiota haemorrhagica* in Grgurinovic (1997), but the microscopic character do not fit as well so has been considered a single taxon with affinities to this species.

Macro-characters Pileus 16-35 mm diam.; umbilicate; off-white to greyish sepia with red-brown radially appresed scales. Lamellae free; crowded to close; white. Stipe to 80 mm long, 2-6 mm diam.; off-white above annulus, greyish sepia below; off-white annulus; greyish sepia appressed scales over base; tapers towards lamellae. Fruit-body bruises blood red with handling, fading with time.

Micro-characters Basidiospores 6.5-8 x 3.5-4.5 µm (x = 7.5 x 3.9 µm); narrowly ellipsoid; hyaline; dextrinoid; smooth. Cheilocystidia common; 24-35 x 7-12 µm (x = 29 x 9 µm); clavate to narrowly clavate; thin-walled. Pileipellis of interwoven filamentous, septate hyphae, thick-walled; grey tint .

Collections SMF1160

Images Lephaem1160fa-b

Lepiota spp. I

This is an artifical grouping of the *Lepiotas* that look different to the two taxa above. There are probably a number of undescribed taxa in this group.

Collections SMF0275, SMF0325, SMF1126, SMF1169, SMF1231, SMF1254, SMF1426

Images LepBM275L, Lep325L, LepWdrops1126L, LepRedB1231F, LepBred1231L, LepGreyB1254L

Lycoperdon aff. *pyriforme* Schaeff. : Pers.

This puffball with its distinct stem is similar to that described as *Lycoperdon pyriforme* in Breitenbach and Kranzlin (1986), but this collection differs as the

exoperidium is globose to subglobose and regular in outline, so it is considered here as a single taxon with character affinity to *Lycoperdon pyriforme*.

Macro-characters Fruit-body 30-50 mm diam.; pyriform to clavate with a distinct sterile base; cream to off white with dense umber elements (<1 mm diam.); ragged mouth (approx. 8 mm diam.). Gleba olive brown at maturity; sterile base cellular and dull ochre to pale umber.

Micro-characters Basidiospores 4 x 4 µm; globose; pedicle absent; thick walled with a smooth; yellow-brown (KOH). Capillitum sparsely branched, thick walled; pores absent.

Collections SMF2031

Images Lyco2031Fa-d, Lyco2031La-f

Lycoperdon sp. A

This puffball matches the concept for this genus in Pegler *et al.* (1995).

Macro-characters Fruit-body 10-33 mm diam.; subglobose with a sterile stipe cream to off white with dense pyramidal warts (approx 0.5 mm diam.); cracks on top but no obvious mouth. Gleba white in immature specimens becoming olive brown at maturity; sterile base spongy and off-white.

Micro-characters Basidiospores 4.4-5 x 3.8-5 µm (x = 4.1 x 4 µm); globose; long pedicle; thick walled with a verrucose surface; yellow-brown. Capillitum not branching with pores.

Collections SMF0013

Macrotyphula juncea (Fr. : Fr.) Berthier

This delicate threadlike taxon was recognised by the macrocharacters. This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Fruit-body up to 80 mm high, branches <1-1 mm diam.; off-white to buff. Stipe distinct.

Collections SMF0303

Marasmiellus affixus (Berk.) Singer

This malodorous basidiolichen (Chapter 2: Figure 7) has small fruit-bodies, which are usually eccentric and a cream to buff colour. The macrocharacters match those in Fuhrer (2005).

Macro-characters Pileus 1-10 mm diam; convex to plano-convex; cream, buff to vinacous-buff, often translucent striate. Lamellae adnate; sub-distant, conclourous with pileus. Stipe up to 4 mm long, <1-1 mm diam.; concolours with pileus; usually eccentric attachment. Strong urea odour.

Micro-characters Basidiospores 7.75-9.25 x 3.75-4.5 µm (x = 8.7 x 4.2 µm); fusiform to ellipsoid; hyaline ; smooth.

Collections SMF1166, SMF1973

Images MaraAff1166La-b, MarAff1973Fa-c, MarAff1973La-b

Marasmius elegans (Cleland) Grgur.

This attractive orange to red-brown capped mushroom is distinctive by the stem which is pale near the gills and orange to orange-brown on the lower half and the velvet texture to the cap. The collection matches the description in Bougher and Syme (1998).

Macro-characters Pileus 4-22 mm diam.; plano-convex, plano, parabolic in immature specimens; burnt apricot, pale sienna, orange, orange-brown; darker in centre; minutely velvet texture. Lamellae adnexed; close; off-white. Stipe up to 70 mm long, 1-3 mm diam.; off-white upper third to half, lower section dark sienna to orange-brown. Basal myceliem white.

Micro-characters Basidiospores 10-11x 4.5-5.5 µm (x = 10.2 x 4.7 µm); fusoid to subfusoid; hyaline ; smooth. Pileipellis of dense rameales made up of clavate elements with diverticulate branches.

Collections SMF2210

Images MaraEleg2210Fa-d, MaraEleg2210La-d

Marasmius sp. A

This *Marasmius* is distinctive by the opaque buff cap with a pink-brown tint in the cap centre (Figure 4). This is probably a undescribed taxon of *Marasmius*.

Macro-characters Pileus 2-10 mm diam.; plano-convex to parabolic; buff and striate at margin, centre fawn, with pink-brown tint; opaque; dry. Lamellae adnate; distant; buff. Stipe up to 60 mm long, <1-2 mm diam.; buff to fawn near lamellae, dark brown lower two-thirds to half.

Micro-characters Basidiospores 9-10 x 3-3.25 µm (x = 9.2 x 3.2 µm); subcylindrical; hyaline ; smooth. Pileipellis of abundant rameales made up of cylindrical elemend with diverticulate branchs.

Collections	SMF2209
Images	Mara2209Fa, Mara2209La-e

Marasmius sp. B

This *Marasmius* is distinctive by having an omphaloid habit. This taxon was recognised based on its macrocharacters and probably represents a single undescribed taxon.

Macro-characters Pileus 10-20 mm diam.; depressed; buff with umber scales; dry. Lamellae decurrent; distant; buff. Stipe up to 30mm long, 1 mm diam.; fucous black; dry.

Collections	SMF1059, SMF1353
Images	MaraDecur1353Fa

Marasmius spp. I

These brown mushrooms are distinctive by their tough texture and brown gills with a white sheen and spore print. This group includes undescribed *Gymnopus* and *Marasmius*; including *Gymnopus* sp. A (collection SMF0162) described in McMullan-Fisher *et al.* (2003).

Macro-characters Pileus 5-40 mm diam.; plane, plano-convex, depressed; brown, fawn; striate; dry. Lamellae adnexed; sub-distant; brown, fawn with white sheen. Stipe up to 70 mm long, 2-6 mm diam.; buff, fawn, brown; dry; narrows towards base.

Collections	SMF0162, SMF0540, SMF1060, SMF1284
Images	GymnAlp162La, Mara540La-b, Mara1060L, Mara1284Fa-b, Mara1284La

Marasmius spp. II

This is a grouping of small, tough, buff capped, often dark stemmed *Marasmius*. This is a group of taxa which are macroscopically similar but which have different characteristics at the microsopic level. Considering the collections microscopic characters it seems likely that there are several separate undescribed taxa.

Macro-characters Pileus 2-10 mm diam.; convex, plano-convex; cream, buff, brown, paler near margin; dry. Lamellae sub-distant to distant; buff, cream, off-white.

Stipe up to 40 mm long, <1-2 mm diam.; cream to buff near lamellae, brown, black lower two-thirds to fifth; dry; tough.

Collections SMF0423, SMF0480, SMF1010, SMF1011, SMF1013, SMF1014, SMF2217, SMF2226

Images MaraHH423L, Mara480L, MaraMt1010L, MaraMt1011L, MaraBuff1013L, MaraAlpHH1014L, Mara2217Fa-b, Mara2226Fa-b, Mara2226La-c

Melanotus hepatochrous (Berk.) Singer

This brown fruit-body is often fan or kidney shaped, attaching by a small but distinct stem. The collection match the description in Horak (1977).

Macro-characters Pileus 3-20 mm diam.; plano-convex, fan- or liver- or kidney-shaped; dark brown, umber, ochraceous; dry; margin inrolled. Lamellae adnate; close; brown. Stipe up to to 7 mm, <1-2 mm diam.; brown; some specimens had fine fibrils near base; eccentric attachment.

Micro-characters Basidiospores 6-8.25 x 3.5-4.5 µm (x = 6.8 x 3.9 µm); ellipsoid to ovate; thick walled; germ pore present; yellow-brown ; smooth. Cheilocystida abundant; 19-33 x 4-6 µm (x = 24 x 4.6 µm); lageniform to broadly lageniform.

Collections SMF1576, SMF2225, SMF2269

Images Mel1576Fa-b, Mel1576La-b, Mel2225Fa-b, Mel2225La-b, Mel2269Fa-d, Mel2269La-b

Mycena albidofusca Cleland

This brown *Mycena* found on litter has a distinctive pallid apex. Both the macroscopic and microscopic characters of the collection match the description in Grgurinovic (2003).

Macro-characters Pileus 3-17 mm diam.; trucate to blunt; dark grey with umber tints, paler dot in centre; translucent striate at margin. Lamellae adnate; sub-distant; white. Stipe up to 80 mm long, 1-2 mm diam.; off-white to pale grey near gills, darkening to umber-grey; some basal hairs.

Micro-characters Basidiospores 7.75-10 x 5-6 µm (x = 8.3 x 5.7 µm); ellipsoid; amyloid; smooth. Cheilocystidia sparce; ventirose-rostrate, cylindrico-rostrate, clavate. Hymenophoral trama dextrinoid.

Collections SMF2271

Images Myc2271Fa-b, Myc2271La-b

Mycena austrofilopes Grgur. & A.A.Holland

This brown *Mycena* found on litter, may be distinguished from *Mycena cystidiosa*, which it most resembles, by the distinct pale ring around the edge of a conical cap; the lamellae are close to sub-distant and there is also an absence of sterile stipes which are common in *M. cystidiosa*. The macro- and micro-characters of collections match the description in Grgurinovic (2003).

Macro-characters Pileus 17 mm diam.; conical, campanulate and parabolic; hazel, fawn to buff brown in centre paling towards margin; dry, at times translucent striate at margin. Lamellae adnexed; close; white. Stipe up to 100 mm long, 1-2 mm diam.; isabelline, greyish sepia, often paler near gills; abundant hairs at base.

Micro-characters Basidospores 10-11 x 5.75-6.5 µm (x = 10.8 x 6.1 µm); ellipsoid; amyloid; smooth. Cheilocystidia aubundant, forming a sterile edge; 18-25 x 9-15 µm (x = 21 x 11.2 µm); clavate, obpyriform to sphaeropedunculate with short cylindric to longer diverticulate excresences. Hymenophoral trama dextrinoid.

Collections SMF1058, SMF1099, SMF2231

Images Myc1099L, Myc2231Fa-b, Myc2231La-b

Mycena austrororida Singer

This paler brown *Mycena* has a pale stipe that is distinctly glutinous. This taxon is commonly found in clusters on woody substrates. The macro- and micro-characters match the description in Grgurinovic (2003).

Macro-characters Pileus to 15 mm diam.; hemispherical; buff, cream, to pale honey; fine grey to brown dots; translucent striate and slightly furrowed at margin. Lamellae decurrent; close; white. Stipe up 18 mm long, up to 1 mm diam.; buff, off-white to smoke grey; abundantly glutinous.

Micro-characters Basidiospores 10-13 x 6-7.8 µm (x = 11.4 x 6.6 µm); ellipsoid, pip-shaped to subglobose; amyloid; smooth. Cheilocystidia common, forming a sterile edge; 30-62 x 9-10 µm (x = 42.8 x 9.2 µm); cylindrical to narrowly clavate, thin-walled; hyaline. Hymenophoral trama dextrinoid.

Collections SMF0399

Images Myc0399L

Mycena banksiae Cleland & Cheel

Smoky, viscid, sulcate-striate capped species of *Mycena* were not separated in the field, so this taxon represents a species complex of *Mycena banksiae, M. carmeliana* and *M. fumosa* as described in Grgurinovic (2003). The characters described below are from a single collection.

Macro-characters Pileus 8-18 mm diam.; convex to hemispherical; off-white to smoke-grey, some with saffron tints; viscid; furrowed and translucent striate at margin. Lamellae adnate to sinuate; close; white. Stipe up to 30 mm long, up to 1 mm diam.; white to buff; base nearly a disk-shape.

Micro-characters Basidiopores 7.75-9 x 4.5-5 µm (x = 8.2 x 4.7 µm); narrowly ellipsoid; inamyloid; smooth. Cheilocystidia common; 30-44 x 11-13 µm (x = 36.4 x 11.8 µm); clavate, broadly clavate, fusoid-ventricose; thin-walled. Pileipellis of filamenous hyphae in a gelatinized layer with common acanthocysts 50-88 x 7-11 µm (x = 84 x 10.8 µm); fusoid to narrowly clavate with nodulose to cylindric excresences. Hymenophoral trama dextrinoid.

Collections SMF0414

Images Myc0414L

Mycena cystidiosa (G.Stev.) E.Horak

This brown *Mycena* found on litter may be distinguished from *M. austrofilopes* which it most closely resembles, by the abundant rhizomorphs (sterile stipes) and the entirely brown pileus. Collections of this species fit the description in Grgurinovic (2003).

Macro-characters Pileus up to 20 mm diam.; conical to papillate; umber to hazel brown, darker in centre; dry. Lamellae adnate; white. Stipe to 200 mm long, 1-4 mm diam.; umber, hazel to isabelline; tapers towards gills; dense basal hairs and mixed with surrounding litter.

Micro-characters Basidiospores 8.25-10 x 5.5-7 µm (x = 9.25 x 6.1 µm); ellipsoid; amyloid; smooth. Cheilocystidia common, forming a sterile edge; 31-45 x 8-10 µm (x = 37.4 x 9.4 µm); clavate to obpyriform with nodulose to cylindric often branched excresences. Pleurocystidia abundant; 65-85 x 16-22 µm (x = 75.4 x 19.2 µm); fusiod-ventricose, lanceolate, apex sometimes bifurcate; thick-walled.

Collections SMF1316

Images Myc1316L

Mycena epipterygia complex

This is a species complex in the section *Hygrocyboideae* (Fr.) Singer as described by Grgurinovic (2003). The collection characters fit within this group but do not allow identifiifcation to any individual species. The species which make up this complex are *M. murna, M. nyula, M. tasmaniensis, M. tuuwuulensis* and *Mycena* sp. indet. B (but not *Mycena* sp. Indet. A as this was recognised as a separate taxon). This complex was recognised in the field by the viscid yellow stipe.

Macro-characters Pileus to 15 mm diam.; truncate, conical, papabolic; grey-brown with olive green tin, paler near margin; viscid, translucent striate. Lamellae adnate to slighly decurrent; close; pale grey to pale grey-brown. Stipe up to 70 mm long, 1-3 mm diam.; bright yellow with green tint; thick gelatinous layer along stipe; base slightly thickened.

Micro-characters Basidiospores 8-10 x 5-6.5 µm (x = 8.7 x 5.6 µm); ellipsoid; amyloid; smooth. Cheilocystidia abundant within a gelatinized layer; cylindric to clavate with many irregular cylindric excresences. Hymenophoral trama dextrinoid.

Collections SMF1157, SMF1970

Images Myc1157F, Myc1970Fa-b, Myc1970La-c

Mycena interrupta (Berk.) Sacc.

This distinctive blue *Mycena* (Chapter 2: Figure 7) matches the description in Grgurinovic (2003). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus up to 10 mm diam.; convex; blue, darker in centre; viscid. Lamellae free; close to crowded; white. Stipe up to 15 mm long, up to 1 mm diam.; white to pale blue, with blue disk at base.

Micro-characters Basidiospores 8-10 x 7-7.5 µm (x = 9.2 x 7.1 µm); broadly elliposid; amyliod; smooth. Cheilocysitidia present within a yellow extracellular layer (KOH). Hymenophoral trama dextrinoid.

Collections SMF2024

Images Myc2024La-b, My2024Fa-b

Mycena kurramulla Grgur.

This mauve *Mycena* is distinguished in the field by the mauve margin on the lamellae. Macro- and micro-characters of the collection match those described in Grgurinovic (2002).

Macro-characters Pileus 3-18 mm diam.; convex to hemispherical; livid vinaceous. Lamellae adnate to decurrent; white with a livid vinaceous margin. Stipe up to to 30 mm long, up to 1 mm diam.; livid vinaceous to vinaceous buff.

Micro-characters Basidiospores 6.5-8 x 3.5-4 µm (x = 7.1 x 3.7 µm); ellipsoid; amyliod; smooth. Cheilocystidia, common; clavate with nodulose to cylindric excresences; contain vinaceous pigment.

Collections SMF0460

Images Myc0460L

Mycena kuurkacea Grgur.

This red-brown *Mycena* may be distinguished by the lamellae with a red-brown margin and the copious red-brown latex. The macro- and micro-characters of the collections match the description in Grgurinovic (2003).

Macro-characters Pileus 3-20 mm diam.; conical, hemispherical, blunt, campanulate, some with papilla; dark blood red to red-brown, pales towards margin; sometimes translucent striate at margin. Lamellae sinuate to adnate; close; off-white with red-brown margin. Stipe up to 100 mm long, 1-3 mm diam.; red-brown, vinacous buff to rust, often darker towards base; basal hairs; stipe exudes red-brown liquid.

Micro-characters Basidiospores 7.75-10.25 x 5-6.5 µm (x = 9.2 x 5.7 µm); ellipsod; amyloid; smooth. Cheilocystidia common, forming a sterile edge; 39-68 x 10-17 µm (x = 41.5 x 14.2 µm); fusiod ventricose, clavate, some with many clyindrical excrescences. Pleurocystidia common; fusiod-ventricose with tapered apex. Hymenophoral trama dextrinoid.

Collections SMF0143, SMF1082, SMF2245, SMF2246

Images Myc0143L, Myc1082L

Mycena mulawaestris Grgur.

This distinctive *Mycena* has brown to black, particularly viscid cap and black emarginate lamellae, it also has distinctive cheilocystidia and a gelatinous pileal surface containing loose brown pigmented hypae. Characters of the collections match the description in Grgurinovic (2003).

Macro-characters Pileus 7-15 mm diam.; conical with an acute papilla, to campanulate; black to dark yellow-brown in centre paling to hazel to grey-brown at margin; viscid to glutinous. Lamellae adnate; close; white with a black margin. Stipe

up to 50 mm long, 1-5 mm diam.; isabellina to grey-brown; dry to viscid; thickens slightly towards base; basal hairs.

Micro-characters Basidiospores 7.5-9.5 x 5.75-6.25 µm (x = 8.5 x 5.7 µm); broadly ellipsoid; amyloid; smooth. Cheilocystidia common; 21-36 x 7-18 µm (x = 27 x 11 µm); clavate, sphaeropeduncluate with cylindric but blunt excresences, fusoid with large irregular cylindric excresences and some deformed cylindric-fusoid cystidia without excresences; brown pigment. Pileipellis of filamentous hyphae in a gelatinized matrix. Hymenophoral trama dextrioid.

Collections SMF1087, SMF1217

Images Myc1087L, Myc1217L

Mycena nargan Grgur.

This dark *Mycena* is particularly distinctive when specimens are young as they have small white spots on the dark cap surface. Characters of the collection matched the description in Grgurinovic (2003). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 5-20 mm diam.; parabolic to conical; hazel, darker in younger specimens nearly olivacious black; white spots, on younger specimens. Lamellae sinuate; close; buff with amber margin. Stipe up to 40 mm long, 1-2 mm diam.; honey to isabelline; white basal mycelium.

Micro-characters Basidiopores 9-10.5 x 5.75-6.5 µm (x = 9.45 x 6.05 µm); broadly elliposid; amyloid; smooth. Cheilocystidia abundant, forming a sterile edge; 24-35 x 5-10 µm (x = 29.6 x 7.5 µm); lagniform to ventricose-rostrate; thin-walled, hyaline. Hymenophoral trama dextrinoid.

Collections SMF1096

Images Myc1096F, Myc1096L

Mycena aff. *neerimensis* Grgur.

This litter based *Mycena* may be recognised from the other brown taxa by having a distinctly honey coloured cap and stipe (Figure 4). Collections are similar to that of *M. neerimensis* described in Grgurinovic (2003) but there was no gluten on the cap, nor latex noted for this taxon, also the substrate from the single collection in Grgurinovic (2003), was a eucalypt branch. This represents a single taxon, which was consistently recognised in the field amongst litter and has character affinities to *Mycena neerimensis*.

Macro-characters Pileus 4-30 mm diam.; umbonate, campanulate, conical, plano-convex; honey, pale amber, hazel; translucent striate at margin, sometimes furrowed; dry. Lamellae sinuate; close; white. Stipe up to 70 mm long, 1-4 mm diam.; honey, paler near lamellae; basal hairs.

Micro-characters Basidiospores 10-12.5 x 5-5.5 µm (x = 11 x 5.2 µm); cylindric; weakly amyloid. Cheilocystidia common; 50-75 x 10-20 µm (x = 62.5 x 15.5 µm); fusoid-ventricose with long tapering necks, sometimes bifurcate or mucronate; thin-walled. Pleurocystida common, similar to cheilocystiHymentophoral trama dextrinoid.

Collections	SMF1024, SMF1053, SMF1081, SMF1085
Images	Myc1081F, Myc1081L, Myc1085L

Mycena subgalericulata Cleland complex

This is a complex of taxa (Chapter 2: Figure 7), which are characterised by having buff, brown, fuscous brown caps and similar coloured stems, these are gregarious to caespitose on woody substrates but not found on litter. These taxa were not separated out in the field, and so represents a large species complex.

Collections	SMF0348, SMF0402, SMF1124, SMF1125, SMF1202, SMF1219, SMF1300, SMF1334, SMF2218
Images	Myc348L, Myc402L, Myc1124L, Myc1125L, Myc1202L, Myc1219L, Myc1300F-e, Myc1300L, Myc1334Fa-b, Myc2218Fa-d, Myc2218La-d

Figure 4. (A) *Marasmius* sp. A, (B) *Mycena* aff. *neerimensis,* (C) *Mycena* aff. *tallangattensis,* (D) *Mycena* sp. A, (E) *Mycena* sp. E, (F) *Omphalina* sp. A, (G) *Omphalina* sp. B, (H) *Porpoloma* sp. A, (I) *Rhodocollybia* sp. A, (J) *Ripartites* sp. A, (K) Tricholomataceae sp. B, (L) *Trogia* sp. A. Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Mycena aff. *tallangattensis* Grgur.

This soft textured *Mycena* is distinctive in its cream to pale tan colouration and commonly has a densly hairy stem base (Figure 4). This taxon also has common cheilocystidia and pleurocystidia which are lanceolate with an acute apex and are clear thick-walled. Collections had affinities with the macrodescription of *M. tallangattensis* Grgurinovic (2003), but the spores were consistently smaller.

Macro-characters Pileus 2-17 mm diam.; convex, plano-convex, depressed; cream, straw, pale ochraceous, pale tan; translucent-striate at margin; dry or tacky. Lamellae decurrent to adnate; concolorous to pileus; distant to sub-distant. Stipe up to 40 mm long, 1-3 mm diam.; concolorous to pileus; dry but occasionally tacky; usually densely hairy at base.

Micro-characters Basidiospores 6-8.5 x 3.25-4 µm (x = 7.8 x 3.6 µm); narrowly ellipsoid to ellipsoid; amyloid; smooth. Cheilocystidia common; 40-75 x 8-13 µm (x = 59.2 x 9.6 µm); lanceolate with an acute apex; thick-walled. Pleurocystidia common and similar. Hymenophoral trama dextrinoid.

Collections SMF0300, SMF1143, SMF1427, SMF1962

Images Myc1143F, Myc1143L, Myc1962Fa-c, Myc1962La-b

Mycena vinacea Cleland complex

This vinacous coloured *Mycena* is common on leaf and twig litter. The macroscopic characters were used to separate these collection in the field. Considering the microscopic characters both *M. vinacea* and *M. nullawarrensis* in Grgurinovic (2003) were present in the collections..

Macro-characters Pileus 6-35 mm diam.; plano-convex, campanulate, convex; brown with vinaceous tints, pink-grey to purple-grey darker towards centre; smooth, dry, translucent striate at margin. Lamellae deeply sinuate; close; off-white to pale pink. Stipe up to 50 mm long, 1-4 mm diam.; concolorous with pileus, paler near lamellae, some specimens yellowing at base; smooth, thicker at base with some basal hairs. Radish odour.

Micro-characters Basidiospores 6.5-8.25 x 2.25-4.5 µm (x = 7.4 x 3.6 µm); narrowly ellipsoid; weakly amyloid. Cheilocystidia abundant, forming streile edge; 40-80 x 10-18 µm (x = 53.8 x 12.8 µm); fusoid with capitate apex, cylindric to narrowly clavate; thin-walled. Pleurocystidia common; 51-65 x 13-20 µm (x = 56.8 x 16.8 µm); clavate to cylindro-ventricose; thin-walled. Hymenophoral trama dextrinoid.

Collections SMF1130, SMF1995

Images Myc1130L

Mycena viscidocruenta Cleland

This tiny bright red, viscid *Mycena* (Chapter 2: Figure 7) is common on litter, collections match the description in Grgurinovic (2003). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 1-6 mm diam.; plano-convex, hemispherical, campanulate; red, scarlet, darker in centre; viscid; translucent striate at margin. Lamellae decurrent; distant; white to pale pink. Stipe up to 20 mm long, up to 1 mm diam.; dark red to scarlet; glutinous; basal disk attachment to substrate.

Micro-characters Basidiospores 7.75-9.5 x 3.25 -4.25 µm (x = 8.6 x 3.6 µm); narrowly ellipsoid; amyloid; smooth. Cheilocystidia abundant, forming a sterile edge; 31 -50 x 7-12 µm (x =40.6 x 9.2 µm); cylindrical, cylindro-ventricose, ventricose-rostrate. Hymenophoral trama dextrinoid.

Collections SMF2211

Images Myc2211Fa-c, Myc2211La-d

Mycena sp. A

This small white capped and dry yellow-stemmed *Mycena* (Figure 4), matches the description of *Mycena* sp. Indet. A (Grgurinovic 2003). This easily recognisable taxon was also found on leaf litter substrates as well as the woody substrates.

Macro-characters Pileus 1-8 mm diam.; convex to plano-convex; white, sometimes pale yellow tints; dry. Lamellae decurren; sub-distant; white. Stipe up to 50 mm long, up to 1 mm diam.; pale yellow near gills becoming bright yellow to amber near base; dry.

Micro-characters Basidiospores 8-10 x 3.25-4.5 µm (x = 8.9 x 3.8); cylindric to narrowly ellipsoid; inamyloid to weakly amyloid; smooth. Cheilocystidia common; 32-47 x 7-9 µm (x = 39.2 x 7.4 µm); cylindric, ventricose-rostrate, fusiform. Hymenophoral trama inamyloid.

Collections SMF0397, SMF0510, SMF1937

Images Myc0510L, Myc1937Fa-e, Myc1937La-e

Mycena sp. B

This dark brown *Mycena* was only found in the alpine environment, its cheilocystidia do not match any taxon described in Grgurinovic (2003). This represents a single undescribed taxon. This taxon was refered to as Mycena sp. (collection SMF0191) in McMullan-Fisher *et al.* (2003).

Macro-characters Pileus 15 mm diam.; conical; margin splits slightly; dark hazel brown, dries paler brown. Lamellae sinuate; pale grey. Stipe up to 20 mm long; pale grey near lamellae darkening for lower half.

Micro-characters Basidospores 12.6-13.8 x 5.5-6.6 (x **=** 13.1 x 6.3 µm); ellipsoid; amyloid. Basidia 4-spored. Scattered cystida clavate to pyrimidiform; hyaline; thin walled.

Collections SMF0191

Images Myc191La-b

Mycena sp. C

This *Mycena* was distinctive with its viscid, dark grey cap and viscid stem. This collection does not match any of the species dealt with by Grgurinovic (2003) and probably represents a single undescribed taxon.

Macro-characters Pileus 3-8 mm diam.; conical to convex; dark grey to isabelline; viscid, tanslusent striate at margin. Lamellae decurrent to adnate; sub-distant; white. Stipe up to to 30 mm long, up to 1 mm diam.; hazel; slimy.

Micro-characters Basidiospores 10.5-13.25 x 5-7.75 µm (x = 11.5 x 6.1 µm); obovoid to narrowly obovoid; weakly amyloid smooth. Cheilocystidia common; irregularly clavate with large irregular, cylindric, often branched excrescences; thin-walled. Hymenophoral trama dextrinoid.

Collections SMF0261

Images Myc261L

Mycena sp. D

This medium sized white to cream *Mycena* may be distinguished from other pale Mycenas by the opaqueness of the cap. This probably represents a single undescribed taxon as it matches none of the descriptions of species dealt with by Grgurinovic (2003).

Macro-characters Pileus 2-12 mm diam.; plano-convex to depressed; white becoming cream when dry; opaque. Lamellae decurrent; white. Stipe up to 20 mm long, up to 1 mm diam.; white; dry.

Micro-characters Basidiospores 10.5-13 x 3.75-4.5 µm (x = 12 x 4.2 µm); subfusiform; inamyloid; smooth. Cheilocystidia common, forming a sterile edge; 25-28 x 5-10 µm (x = 26 x 7.2 µm); narrowly conical to narrowly lageniform; thin-walled. Hymenophoral trama inamyloid.

Collections SMF1093

Images Myc1093L

Mycena sp. E

This colour of this small *Mycena* varies from pale cream to pale pink, and the cap margin is distinctly scalloped (Figure 4). This probably represents a single undescribed taxon as it matches none of the descriptions of species dealt with by Grgurinovic (2003).

Macro-characters Pileus 1-12 mm diam.; plane, plano-convex, depressed, eccentric with central stipe; pale cream, some with pink tint; scallped margin, translucent striate. Lamellae decurrent to adnate; sub-distant; cream. Stipe up to to 3 mm long, up to <1 mm diam.; pale cream; basal disk on some specimens.

Micro-characters Basidiospores 7.5-9 x 6-7.5 µm (= 8 x 6.7 µm); subglobose to globase; weakly amyloid; smooth. Pileal surface with abundant sphaeropedunculate acanthocysts. Hymenophoral trama dextrinoid.

Collections SMF2011

Images Myc2011Fa, Myc2011La-c

Mycena spp. I

These small translucent white Mycenas may be distinguished from other white Mycenas in this study as they are translucent in the cap, gregarious to caespitose on woody substrates. Although the collection is a single undescribed taxon, the small size of this taxon, less than 5 mm in cap diameter, meant that few specimens were of sufficient quality for lodging as vouchers. Thus this will be considered a species complex. The collection did not match the descriptions of the white taxa in Grgurinovic (2003): *Mycena albidocapillaris, M. austrororida, M. minya, M. nivalis, M. piringa, M. subalbida*, and *Mycena* sp. indet. A.

Collections SMF1132

Images Myc1132fa-c, Myc1132L

Mycena spp. II

This is a group of taxa which have buff, brown or fuscous brown caps which are not viscid, and are found on leaf and twig litter. Considering the collections this group contains the species *M. marangania* and *M. maldaea* described in Grgurinovic (2003) plus three undescribed taxa.

Collections SMF0421, SMF0503, SMF1048, SMF1148, SMF1210, SMF1215

Images Myc1048La-b, My1148F, My1148L, Myc1210La-b, Myc1215L

Mycena spp. III

This is a group of taxa which are white, usually translucent and are found on leaf and twig litter. This group has been separated from *Mycena* spp. I by the substrate and *Mycena* sp. D because that is opaque. There may be a number of taxa in this group. No collections were retained.

Nidula niveotomentsa (Henn.) Lloyd

This tiny vase-shaped birds nest fungus has finely woolly buff coloured cups which contain brown peridioles which are not attached by a thread. Collections matched description in Brodie (1975).

Macro-characters Cup up to 5 mm long, 1-4 mm diam.; sides of cup are straight; outer surface buff to ochraceous with finely woolly texture. Peridioles are dark brown and are not attached by a thread.

Collections SMF1961, SMF1990

Images Birdsnest1961Fa-b, Birdsnest1961La-c, BirdNest1990Fa-b, BirdNest1990La-b

Omphalina chromacea (Cleland) T.W.May & A.E.Wood

This bright yellow *Omphalina* is distinctive by the scalloped gill margin and bright yellow colour of the whole fruit-body. The collections match the description in

Bougher and Syme (1998). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 2-16 mm diam.; depressed to hemispherical, scalloped margin; bright yellow to yellow, translucent striate. Lamellae decurrent; yellow; sub-distant. Stipe up to 20 mm long, <1-1 mm diam.; yellow; smooth.

Micro-characters Basidiospores 6.5-9 x 4-5.25 µm (x = 7.7 x 4.5 µm); ellipsoid to broadly ellipsoid; hyaline; inamyloid; smooth.

Collections SMF0208, SMF1147, SMF2278

Images OmpChr208L, OmphChrom2278Fa-d, OmphChrom2278La-c, Omph1147L

Omphalina umbellifera (L. : Fr.) Quél.

This ochraceous to orange-brown coloured *Omphalina* is similar in size and shape to *Omphalina chromacea* but is never a bright yellow, although as this is hygrophanous collections may dry to a dirty pale yellow. The cap margins are translucent striate but are not deeply scalloped. Collections match the macrocharacters in Fuhrer (2005).

Macro-characters Pileus 5-15 mm diam.; depressed to umbilicate; pale ochraceous, sienna, fulvous, orange-brown; translucent striate. Lamellae decurrent; sub-distant; pale ochraceous to buff. Stipe up to to 15 mm long, <1-2 mm diam.; concolorus with pileus; white basal tomentum often present.

Micro-characters Basidiospores 7-8 x 4.5-5.5 µm (x = 7.5 x 4.8 µm); broadly ellipsoid; hyaline; inamyloid; smooth.

Collections SMF0351, SMF1535, SMF2276

Images OmpOr1535La-c, Omph2276Fa-b, Omph2276La-b

Omphalina sp. A

This *Omphalina* was distinguished by its short robust habit and dark brown/grey colour, and was always found on cushion plants which have an alpine distribution (Figure 4). This is proably a single undescribed taxon.

Macro-characters Pileus 5-16 mm diam.; plano-convex to depressed with inrolled edge; translucent striate margin; fucious black to dark umber with slight red tint. Lamellae decurrent; close; thick; concolourous with pileus. Stipe up to 6 mm long; short and thick, broader near lamellae; concolours with pileus.

Micro-characters Basidospores 10-11 x 6.4-9.2 µm (x = 10.6 x 7.9 µm); subglobose to globose; hyaline. Basidia clavate. Pileus has interwoven, radially arranged, repent hyphae, hyphae contain brown pigmentation (Meltzers reagent). Tramal hyphae have clamps and some have oily contents.

Collections SMF0163, SMF0167, SMF0188, SMF1030, SMF1031

Images Omp163La-c, Omph0188La-b, Omp1030La-c, Omp1031La

Omphalina sp. B

This buff coloured omphaloid taxon was only found in alpine areas (Figure 4). This is probably a single undescribed taxon.

Macro-characters Pileus 2-8 mm diam.; plano-convex to depressed; pale yellow-buff with darker radially striate. Lamellae decurrent; subdistant; buff. Stipe to 15mm; smooth; concolorous to the pileus or darker brown.

Micro-characters Basidiospores 6.6-8.8 x 3.3-4.4 µm (x = 7.7 x 3.6 µm); ellipsoid, pip-shaped, subcylindrical; hyaline; smooth. Basidia 4-spored.

Collections SMF1318, SMF1530

Images OmpAlp1318Fa-d, OmphAlp1318L

Picture

Omphalina sp. C

This dun brown coloured *Omphalina* was found once in an alpine area. This taxon was longer and paler than *Omphalina* sp. A but darker than *Omphalina* sp. B. The spores were also much broader than those of *Omphalina* sp. B. This is probably a single undescribed taxon.

Macro-characters Pileus 11-15 mm diam.; depressed to umbilicate; dun brown, hygrophanous; margin inrolled, translucent striate, with slight scalloping at lamellae. Lamellae decurrent; sub-distant, slightly forked; buff. Stipe up to 15 mm long, 1-2 mm diam.; buff; white basal tomentum.

Micro-characters Basidiospores 7.7-10 x 5.5-7.7 µm (x = 8.8 x 6.8 µm); subglobose to broadly ellipsoid; smooth.

Collections SMF0014

Omphalotus nidiformis (Berk.) O.K.Mill.

This fleshy mushroom is mostly off-white but darkens in the centre of the cap. The collection described below is at the smaller end of most descriptions. It matches the description from Bougher and Syme (1998).

Macro-characters Pileus 30-50 mm diam.; depressed; off-white to buff becoming grey towards centre; smooth. Lamellae decrrent; close; ivory. Stipe up to 50 mm long, 5-10 mm diam.; cream to ivory near lamellae becoming grey with purple tints near base; slightly eccentric attachment.

Micro-characters Basidiospores 6.75-8 x 5.25-5.5 µm (x = 7.6 x 4.5 µm); broadly ellipsoid; hyaline; inamyloid; smooth. Cheiolocystidia present. Pileial surface filamentous.

Collections SMF0132

Panellus stipticus (Bull. : Fr.) P.Karst.

This species is recognisable by the buff coloured fruit-body, which often has a tacky to sticky pileal surface, and by the lateral attachment by a distinctive stumpy stem. Collections match the description in Grgurinovic (1997).

Macro-characters Pileus 3-40 mm diam.; convex, fan shaped with eccentric attachment; buff; sticky, peachy texture when dry. Lamellae adnate; close; buff. Stipe up to 8 mm long, 2-6 mm diam.; buff, short and wide, with lateral attachment.

Micro-characters Basidiospores 4-4.5 x 2-2.5 µm (x = 4.4 x 2.4 µm); narrowly ellipsoid; hyaline; amalyoid; smooth. Cheilocystidia abundant; narrowly fusiform to narrowly clavate, often with diverticulate and branching apexes.

Collections SMF0296, SMF1580

Images PanStip1580Fa-b, PanStip1580La

Pholiota highlandensis (Peck) Quadr.

This medium sized mushroom is recognisable by its yellow-cinnamon cap, which is often viscid to touch. Specimens seen in this study were lighter in colour and more yellow than the description in Grgurinovic (1997), but micro-characters fit.

Macro-characters Pileus 8-15 mm diam.; convex; sometimes viscid; pale yellow to fulvous to cinnamon in centre. Lamellae adnate; close; buff. Stipe up to 20 mm long, 1-2 mm diam.; pale yellow near lamellae becoming cinnamon near base.

Micro-characters Basidiospores 6-7 x 3.5-4.5 µm (x = 6.3 x 4.3 µm); ellipsoid with germ pore; yellow-brown; smooth. Cheilocystidia common; cylindro-

ventricose. Pleurocystidia common; digitate to narrowly fusiod-ventricose; somewhat thick walled.

Collections SMF1181, SMF1239, SMF1240

Images Phol1239L, Phol1240F, Phol1240L

Pholiota multicingulata E.Horak

This medium yellow-brown mushroom has a cap that is usually glutinous and which dries to a radially fibrillose texture, the stem has distinctive bands of scales. The collections generally fit the description in Bougher and Syme (1998).

Macro-characters Pileus 8-45 mm diam.; campanulate, umbonate to plano-convex; often glutinous, brown radially fibrillose; brown to yellow brown at margin, paler in juveniles. Lamellae adnate to sinuate; close; pale yellow to buff-brown. Stipe up to 40 mm long, 2-15 mm diam.; scales in semi-regular bands along length of stipe; colour varies from sienna to brown near lamellae to buff to brown coloured at base; base thick to swollen.

Micro-characters Basidiospores 7.5-9 x 4.5-5.5 µm (x = 8.4 x 5.2 µm); ellipsoid with a germ pore; yellow-brown; smooth. Cheilocystidia common; 45-71 x 9-14 µm (x = 59.5 x 11.4) µm; ventricose-rostrate to fusoid-ventricose; most contain yellow pigment, some have crystals on upper section. Pleurocystida common; similar to cheiolocystidia.

Collections SMF0328, SMF0456, SMF1114, SMF1190, SMF1214, SMF1351, SMF1996, SMF1997, SMF2009

Images Phol1190L, Gymno1214L, Gymn1351Fa-b, Gymn1351La-c, Phol1996Fa-b Phol1996La-e, Phol1997Fa-d, Phol1997La-h, Phol2009Fa, Phol2009La

Pholiota squarrosipes Cleland

The collection matches the description in Grgurinovic (1997). This may be distinguished in the field from *P. multicingulata* by the irregular pattern of the scales on the stipe. Micro-characters are also quiet different to those of *P. multicingulata*.

Macro-characters Pileus hemispherical to convex; scales umber, densest near margin; amber to ochreous in centre becoming pale yellow at margin. Lamellae sinuate; close; honey coloured. Stipe up to 20 mm long, 1-3 mm diam.; amber near

lamellae, darkening to cinnamon on lower half with irregular umber scales; white basal mycelium present.

Micro-characters Basidiospores 6.5-7 x 4.25-4.5 µm (x = 6.8 x 4.4 µm); ellipsoid; thick walled with a germ pore; yellow-brown. Cheilocystidia common; digitate, conical, narrowly fusiform; hyaline. Pleurocystidia common; 38-50 x 9-14 µm (x = 45.4 x 11 µm); shape similar to cheilocystidia; some with yellow contents.

Collections SMF0581

Pholiota sp. A

This taxon, although undescribed in the literature, is distinctive by the viscid-glutinous layer covering the stipe from just below the lamellae and the viscid orange-brown cap.

Macro-characters Pileus 10-22 mm diam.; convex to plano-convex; viscid; sienna at centre grading to orange to yellow at margin; translucent striate at margin. Lamellae adnate; close; buff to pale yellow. Stipe up to 50 mm long, 3-6 mm diam.; pale yellow glutinous sheath on lower two-thirds; buff near lamellae.

Micro-characters Basidiospores 10-12 x 5.5-6.5 µm (x = 10.6 x 6.1 µm); ellipsoid; thick walled with a germ pore; yellow-brown; smooth. Cheilocystidia common; 33-38 x 10-13 µm (x = 35.2 x 12 µm); fusiform with mucronate apex to broadly digitate; thin walled; chrysocystidioid.

Collections SMF1440

Images Phol1440La-c

Pholiota sp. B

This very bright yellow taxon was distinctive in the field, but the collection may be immature as the spores are small and infrequent.

Macro-characters Pileus up to 30 mm diam.; convex; bright yellow to amber. Lamellae amber. Stipe amber. Specimen growing within a log so is slightly deformed.

Micro-characters Basidiospores infrequent and possibly immature; 6-6.5 x 5.5-6 µm; globose to subglobose; hyaline; smooth. Cheilocystidia common, 40-60 x 9-11 µm (x = 50.4 x 10.6 µm); clavate to narrowly utriform; yellow colour. Gill trama yellow colour.

Collections SMF1216

Images Phol1216L

Pleuroflammula flammea (Murr.) Sing.

This small eccentric mushroom has a yellow to ochraceous colour and is distinctively bright at the cap margin. Collections fit the description in Horak (1978).

Macro-characters Pileus 1-10 mm diam.; convex with eccentric stipe attachment; yellow to ochraceous, particularly bright at the margin; with fine sienna scales concentrated at the centre. Lamellae adnate; close; pale yellow. Stipe up to to 3 mm, <1-1 mm diam.; pale yellow to ochraceous; smooth near lamellae with fine yellow scales below.

Micro-characters Basidiospores 7.5-9.5 x 5.5-6.5 µm (x = 8.6 x 6.1 µm); broadly ellipsiod to ovoid; yellow-brown; smooth. Cheilocystidia common, forming a sterile edge; 24-45 x 4-9 µm (x = 33 x 6 µm); narrowly clavate to cylindro-clavate, apex usually capitate; some contain yellow pigment (KOH).

Collections SMF1057, SMF2250

Images Pleur1057L, Pleur2250Fa-b, Pleur2250La

Pluteus atromarginatus (Konrad) Kühner

This dark capped *Pluteus* has a distictive dark margin on the gills; this collection matches the macrodescription in Bougher and Syme (1998).

Macro-characters Pileus 40 mm diam.; plano-convex; umber; finely tomentose. Lamellae free; close; pale pink with umber margin. Stipe up to 45 mm long, 4-6 mm diam.; white with dark longitudinal fibrils; attached by disk at base.

Collections SMF0461

Images Plut461L

Porpoloma sp. A

This robust yellow mushroom is distinctive by the fawn woolly veil remnants on the cap and stem surface (Figure 4). The burgundy reaction of the tissue in KOH is is distinctive. This taxon matches the genus concept of *Porpoloma* in Singer (1986).

Macro-characters Pileus 25-75 mm diam.; convex, umbonate, plano-convex; pale yellow to straw coloured with woolly fawn veil remnants. Lamellae adnexed, sinuate; close; pale yellow to straw. Stipe up to 70 mm long, 6-18 mm diam.; pale yellow to straw, with vinaceous buff to fawn veil remnants on lower quarter; base slightly bulbous.

Micro-characters Basidiospores 9-10 x 5.5-6 µm (x = 9.6 x 5.8 µm); ellipsoid; hyaline ; amyloid; smooth. Pileipellis of interwoven hyphae, pale burgundy (KOH).

Collections SMF1511, SMF1512

Images TriY1511Fa-b, TriY1511La-b, TriY1512Fa-b, TriY1512La-c

Psathyrella echinata (Cleland) Grgur.

This distinctive *Psathyrella* was found in clusters and the younger specimens had dense spiny scales on the cap. The fruit-bodies observed matched the description in Grgurinovic (1997). No collection was retained.

Psathyrella spp. I

These taxon had brittle brown-capped fruit-bodies that were recognised by their morphology and were grouped in the genus *Psathyrella*. Some were small and on wood while others were larger and found on the ground, so there are probably a number of taxa in this group. This group does not include *Psathyrella echinata* described above.

Collections SMF0580, SMF2018, SMF2019, SMF2200, SMF2228

Images Psath2018Fa-b, Psath2018La-b, Psath2019Fa-b, Psath2019La-c, Psath2200Fa-c, Psath2200La-b, Psath2228Fa-c, Psath2228La-c

Pseudobaeospora spp.

This is a group of collybiod taxa which have an opaque look with pink to purple tones in the cap. This group has the distinctive microscopic character of some of the spores being dextrinod in Meltzers reagent. Collections match the description for this genus in Bas *et al.* (1995). More work needs to be done to elucidate the number of species found in Tasamania.

Macro-characters Pileus 6-30 mm diam.; papillate to umbonate; fawn, chestnut, darker in centre with pink, vinaceous buff or purple tints; dry, opaque; fine peachy texture. Lamellae adnate; close; pale pink, vinaceous buff, vinaceous grey. Stipe up to 40 mm long, 1-4 mm diam.; fawn, chestnut, rust, red; white basal mycelium.

Micro-characters Basidiospores 4-5.5 x 3-4 µm (x = 4.6 x3.4 µm); broadly ellipsoid to subglobose; some dextrinoid; smooth.

Collections SMF1352, SMF1354, SMF1480

Images Pseudobae1352Fa-b, Pseudobae1352La, Pseudobae1354Fa, Pseudobae1354Lb, Pseudobae1480Fa-b, Pseudobae1480La-b

Psilocybe aff. *musci* Cleland & Cheel

These collections fit the description in Grgurinovic (1997), but did not blue with handling, neither were they obviously viscid although one collection did have a particularly shiny cap which is a common indication of a viscid surface. Despite these differences the microscopic characters fit well, so this is considered a single taxon with affinities with *Psilocybe musci*.

Macro-characters Pileus 8-12 mm diam.; convex, hemispherical; hygrophanous; cinnamon to sienna brown. Lamellae close; concolourous to pileus. Stipe up to to 15 mm long, 1-2 mm diam.; concolourous to pileus; with fibrillose veil remains.

Micro-characters Basidospores 7.7-9.3 x 4.5-6.1 µm (x = 8.1 x 5.3 µm); broadly ellipsiod to subglobose, slightly angular towards germ pore and or apiculus; medium walled with a germ pore; red-brown. Basidia 4-spored. Cystidia are common, lecythiform; with long filiform necks.

Collections SMF0189, SMF0451

Images Psil189La-f, Psil450L

Psilocybe subaeruginosa Cleland

This common brown mushroom, although variable, is distinctive as it blues with handling and has a dark spore print. This species was regonised based on its macrosopic characterisitics and matches the description in Grgurinovic (1997).

Macro-characters Pileus 25-50 mm diam.; convex, plano-papillate; ptaney, honey pale yellow to brown; translucent straite; smooth. Lamellae adnexed to free; honey to olivacious buff; close. Stipe up to to 120 mm, 3-6 mm diam.; honey to brown, paler near lamellae; veil remnants present; white basal tomentum. Blues with handling.

Collections SMF310, SMF1310, SMF1350

Images PsilBlueM1310L, PsilBig1350Fa-b

Resupinatus subapplicatus (Cleland) Grgur.

This laterally attached, grey species does not have a stem. The collection matches the description in Grgurinovic (1997).

Macro-characters Pileus 1-12 mm diam.; lateral attachment; pale grey to grey brown; fine velevety texture. Lamellae close; concolorous with pileus. Stipe absent.

Collections SMF2102

Images Resup2102Fa-b, Resup2102La-d

Rhodocollybia butyracea (Bull. : Fr.) Lennox

This species is common in a number of environments in Australia (May *et al.* 2004), and the collections match the description in Fuhrer (2005). This species is similar to but distinctive from *Rhodocollybia* sp. A described below.

Macro-characters Pileus 25-45 mm diam.; translucent striate at margin; caramel brown. Lamellae free; close; buff. Stipe up to 120 mm long; tough; brown.

Micro-characters Basidiospores 5.5-7.7 x 2.2-3.8 µm (x = 6.8 x 3.3 µm). Basidia 4-spored.

Collections SMF0011, SMF1015

Images ColButAlpFa-c

Rhodocollybia sp. A

This large brown mushroom has a distinctive longitudinally striate stem (Figure 4). The size and stem striation separate this taxon from *Rhodocollybia butyracea* sensu stricto, as characterised above. This taxon is probably undescribed, and belongs in the same group as *Rhodocollybia butyracea*.

Macro-characters Pileus 18-40 mm diam.; campanulate, convex, plano-convex; fawn, dark brick; translucent straite at margin. Lamellae sinuate; close; buff. Stipe up to 75 mm long, 3-8 mm diam.; buff, fawn; longitudinally fibrillose; fine appressed scales near lamellae.

Micro-characters Basidiospores 9-10 x 4.75-5.5 µm (x = 9.7 x 5.1 µm); ellipsoid to subfusiform; hyaline ; smooth. Cheilocystidia 31-70 x 3-5 µm (x = 50 x 4 µm); abundant; narrowly cylindrical to aculate; with basal clamp.

Collections SMF0395, SMF1118, SMF1151,

Images Coll0395L, Col1118F-b, Col1118L, Col1151f, Col1151L

Rhodocybe spp. I

This group is characterised by fruit-bodies which have short robust stature, clitocyboid form and an opaque brown to grey colour. This is a group of morphologically similar Rhodocybes and perhaps shorter, thicker stemmed brown Entolomas; this group probably contains a few taxa. This group is distinct from the *Rhodocybe* spp. II described below. This taxon was only observed from heathy vegetation types.

Macro-characters Pileus 10-30 mm diam.; plane, depressed, umbilicate; buff, greyish sepia, smoke grey, hazel all with opaque lustre; finely velvet to peachy texture. Lamellae decurrent; close; buff, greyish sepia to hazel. Stipe up to 30 mm long, 2-5 mm diam.; concolourous with pileus; tapering towards base.

Collections SMF0214, SMF0215, SMF0255, SMF1414, SMF1234, SMF1235

Images Ento214L, Entopq214L, Rhodopa215L, Entopa255La, Rhod1234F, Rhod1234L, Rhod1235L

Rhodocybe spp. II

These buff tricholomatoid agarics are not particularly distinctive and require a spore print or microscopic checking to confirm the genus. Comparison of spores suggests that there are two taxa in this group. These taxa were found in wet forest vegetation.

Macro-characters Pileus 40-70 mm diam.; plano-convex to depressed; ochraceous, tan, fulvous; smooth. Lamellae adnate; fawn to rosy buff; crowded. Stipe up to 50 mm long, 6-15 mm diam.; buff, tan, off-white.

Collections SMF1121, SMF1400

Images Rhod1121L, Rhodo1400F, Rhodo1400L

Rickenella fibula (Bull. & Vent. : Fr.) Raithelh.

This long, delicate, orange clearly decurrent species is usually found growing up through moss in abundance. Although this shares a number of characters with orange *Omphalina* taxa which are more robust in form, this species has a much

longer stem, which is hirsute if viewed with a hand lense. The collection matches the macrodescription in Bougher and Syme (1998).

Macro-characters Pileus 1-10 mm diam.; depressed, convex; orange to pale yellow, often with a distinct orange spot in the centre; translucent striate at margin. Lamellae decurrent; distant; pale yellow to off-white. Stipe up to 45 mm long, <1-2 mm diam.; orange to pale yellow-orange; finely hirsute. White basal tomentum common.

Collections SMF2214

Images RicFibSMF2214Fa-c, RicFibSMF2214La-d

Ripartites sp. A

This pale, decurrent taxon with a slightly viscid cap surface fits the description of *Ripartites* in Bas *et al.* (1995), as does the description of the spores (Figure 4). This may be mistaken for a robust *Hygrocybe* or a decurrent *Cortinarius* aff. *alboviolaceus* but it is distinct.

Macro-characters Pileus 5-15 mm diam.; depressed; buff to off-white; fine peachy texture. Lamellae decurrent; close; off-white. Stipe up to 20 mm long, 2-4 mm diam.; buff to off-white; tapers towards base.

Micro-characters Basidiospores 5.25-6.5 x 4-5.75 µm (x = 6 x 4.9 µm); broadly ellipsoid to subglobose; pale yellow to hyaline; asperulate, verucose to spinose.

Collections SMF1301

Images Rip1301L, Rip1301Fa-b

Simocybe phlebophora E.Horak

This small kharki species might be mistaken for a small *Psathyrella*, but the reticulate pileus and olivacious tint are distinctive. This matches the description in Horak (1980b).

Macro-characters Pileus 6-15 mm diam.; convex; kharki, greenish glaucous, olivacious buff; translucent striate at margin; reticulate texture, particularly in centre. Lamellae free; crowded; olivacious buff. Stipe up to 30 mm long, 1-3 mm diam.; honey; sparce, minute scales present.

Micro-characters Basidiospores 6.75-7.5 x 4.5-5 µm (x = 7 x 4.6 µm); ellipsoid; yellow-brown (KOH); smooth. Cheilocystidia 38-55 x 8-11 µm; lecythiform with capitate apex; thin-walled.

Collections	SMF1282
Images	Simo1282Fa-b, Simo1282La-b

Strophariaceae spp.

These collections were scanty material of 'little brown mushrooms', not distinctive in the field but for the dark look to the gills, so are assumed to be in the common dark spored family. Collections that were made are probably *Hypholoma* and *Psilocybe* taxa.

Macro-characters	Pileus convex brown. Lamellae brown. Stipe brown. Spore print dark.
Collections	SMF0161, SMF0560, SMF0562, SMF1460
Images	Stro161La-b

Stropharia sp. A

This *Stropharia* taxon has a particulary elegant form which, with its pale yellow patches on the cap and creamy yellow stem, is distinctive. This taxon was recognised based on the macrocharacters.

Macro-characters	Pileus 25-35 mm diam.; plano-convex, umbonate; fawn, honey, hazel; cream, pale yellow patches on margin, some appendiculate. Lamellae adnexed, sinuate; crowded; pale grey to fawn. Stipe up to 80 mm long, 4-6 mm diam.; cream to pale yellow; brown fibrils scattered on lower two-thirds. Basal mycelium white.
Collections	SMF1080, SMF1117
Images	Stro1080F, Stro1080L, Stro1117f

Tricholoma spp. I

These grey *Tricholomas* vary from small to large and robust, all have grey in their caps and stems. This taxon was grouped in the field based on macrocharacteristics, there may be a few taxa in this group based on micromorphology.

Collections	SMF0327, SMF0431, SMF1123, SMF1213, SMF2037
Images	Tric0327L, Tric0431L, Tric1123L, Tric1213L, Tric2037Fa-e, Tric2037La-e

Tricholomataceae sp. A

This single collection was somewhat deformed by the harsh growing conditions of the alpine zone, and was possibly immature, but was nonetheless distinctive by the laterally attached habit, and viscid pileus with vinacious tints. Microscopic characters rule out *Panellus longinquus* (Singer 1986).

Macro-characters Pileus approximately 21 mm diam.; laterally attached, pluratiod; viscid; translucent striate; fawn to vinacous buff. Lamellae vinacous buff. Stipe reduced.

Micro-characters Basidiospores rare. Basidia clavate, 2-, 3-and 4-spored, sterigmata are straight to slightly curved. Cystidia common, ventricose. Pileipellis has a surface layer of thin gelatinized hyphae.

Collections SMF0475

Images Tric0475La-b

Tricholomataceae sp. B

This campanulate, decurrent off-white taxon is slightly eccentrically emergent from *Olearia or Bedfordia* wood (Figure 4) and looks a bit like a pale *Armillaria* but does not fit well into any of the described genera, so has been placed under the family Tricholomataceae.

Macro-characters Pileus 3-40 mm diam.; campanulate; off-white to buff; dry; translucent striate; very fine radially fibrillose. Immature specimens have off-white partial veil. Lamellae decurrent; sub-distant; off-white. Stipe up to 55 mm long, 2-8 mm diam.; off-white; dry; tapers towards base.

Micro-characters Basidiospores 11-16.5 x 4.5-6.5 µm (x = 13.7 x 5.4 µm); navicaulate, narrowly ellipsoid, cylindric; hyaline; thin-walled; smooth; inamyloid.

Collections SMF1168, SMF1205

Images TricW1168Fa-b, Tric1168L, Tric1205fa-b, Tric1205L

Trogia sp. A

This large watery taxon has a distinct depressed cap with decurrent and interveined gills (Figure 4). The collection matches the description and image in Fuhrer (2005).

Macro-characters Pileus 15-40 mm diam.; convex in immature specimens, depressed to infundibuliform in mature specimens; dark grey to grey-brown; smooth; translucent striate at margin. Lamellae decurrent, interveined; sub-distant; grey.

Stipe up to 60 mm long, 1-8 mm diam.; grey to buff with pale grey longidtudional fibrils.

Micro-characters Basidiospores 9 x 5.5 µm; ellipsoid; smooth. Cuticle made up of cylindrical hypae with clamp connections.

Collections SMF2004

Images Trog2004Fa, Trog2004La-b

Tubaria spp.

These brown mushooms were distinctive to genus by the hygrophanous, sienna coloured cap, the gills margin being dentate and the stipe usually has persistant cortina. Considering the collections there may be two or three similar looking taxa based on the microscopic characters. This group does not include *Tubaria rufofluva* which has a distinctive maroon-brown cap colour (Grey and Grey 2005).

Macro-characters Pileus 6-30 mm diam.; convex; sienna, fawn, dark brick; hygrophanous; striate at margin. Lamellae adnate; close; concolourous with pileus; margin finely dentate. Stipe up to 40 mm long, 1-6 mm diam.; concolorous with cap longitudinally fibrillose with persistent cortina.

Collections SMF1120, SMF1311, SMF1312, SMF1430, SMF1431, SMF2232

Images Tub1120La-b, Tub1311L, Tub1312L, Tub2232Fa, Tub2232La-b

Xerula australis (Dörfelt) R.H.Petersen

This distinctive species has a long, pale, elegant stem and viscid, plane brown cap. The collections match the description in Bougher and Syme (1998). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 28-32 mm diam.; plano-convex; umber to isabelline; gelatinous to viscid surface. Lamellae adnexed to sinuate; close; white. Stipe up to 180 mm long, 3-4 mm diam.; white near lamellae becoming buff towards base; fine appressed scales scattered along surface; radicating base.

Micro-characters Basidiospores 14.25-18.75 x 10-12 µm (x = 16.5 x 11.1 µm); broadly ellipsoid; hyaline; inamyloid; smooth. Cheilocystidia abundant, some tinted brown (KOH). Pleurocystidia abundant; similar to cheilocystia. Pileipellis is a layer of globose to pyriform terminal elements.

Collections SMF1165

Images Xer1165f

Boletales

Austroboletus aff. *occidentalis* Watling & N.M.Greg.

This large sticky bolete (Figure 5) is macroscopically similar to the species described by Watling and Gregory (1986). Collections from this study had spores in the range of 17.5-23 x 5-6.5 µm which is larger than the spores described.

Macro-characters Pileus 25-100 mm diam.; convex, parabolic in young specimens; pale yellow, pale peach, fawn-brown; stickly with suede texture covered with orange beads of liquid; appendiculate margin, cream to buff coloured. Hymenium pores <1 mm diam; adnate; pale pink, white in young specimens. Stipe up to 120 mm long, 10-45 mm diam.; deeply reticulate; off-white, cream, becoming yellow, ochraceous with age; sticky texture. Very bitter.

Micro-characters Basidiospores 17.5-23 x 5-6.5 µm (x = 20.1 x 5.8 µm); narrowly fusiform, pale yellow-brown; finely punctate. Cheilocystidia and pleurocystidia are present and septate.

Collections SMF0134, SMF1293, SMF2235

Images Austrobol1293Fa-b, AustrobolS1293L, Austrobol2235Fa-h, Austrobol2235La-j

Austropaxillus muelleri (Berk.) Bresinsky & M.Jarosch complex

This yellow, deeply decurrent taxon clearly belongs in *Austropaxillus*. There are two species, *A. muelleri* and *A. infundibuliformis,* which are similar macroscopically Bougher and Syme (1998) so identification to species requires chekcing of microscopic charcters.

Macro-characters Pileus up to 60 mm diam.; infundibuliform; deep yellow with fine brown scales; margin slightly inrolled. Lamellae decurrent; furcate; deep yellow; close. Spore print rust. Stipe up to 30 mm long, 9 mm diam.; yellow; dry; white basal mycelium.

Collections SMF2260

Images Pax2260Fa-b, Pax2260La-b

Boletellus ananiceps (Berk.) Singer

This Bolete (Chapter 2: Figure 8) has distinctive woolly tufts to the cap, it also has yellow pores which bruise blue. Details of the basidiospores and pleurocystidia from the collections match the descriptions in Grgurinovic (1997) and Bougher and Syme (1998).

Macro-characters Pileus 70-150 mm diam.; convex; buff to dirty-white; woolly tufts; appendiculate margin. Hymenium pores > 1 mm; yellow, bruise blue. Stipe up to 120 mm long, 12-30 mm diam.; yellow near hymenium, buff to dirty-white below; fine longitudinal fibres; base swollen.

Micro-characters Basidiospores 16.5-19.25 x 6-7 µm (x = 17.9 x 6.5 µm); subfusiform to elongate ellipsoid; pale yellow-brown; spiralling, longitudinal ridges. Pleurocystidia present.

Collections SMF0131, SMF1912

Images Bolana1912Fa-c, Bolana1912La-c

Boletellus obscurecoccineus (Höhn.) Singer

This burgundy bolete (Chapter 2: Figure 8) stands out on the forest floor due to its finely velvety cap and bright yellow pores. Collections match the description in Bougher and Syme (1998). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 10-40 mm diam.; convex; burgandy to dark maroon; fine velvet texture. Hymenium pores < 1 mm; bright lemon yellow. Stipe 6-15 mm diam.; pale yellow near hymenium, burgandy below, often textured.

Micro-characters Basidiospores 17.5-22 x 5.5-6.5 µm (x = 20 x 6.1 µm); narrow subfusiform; pale yellow-brown; longitudinal ridges.

Collections SMF0121, SMF0140, SMF2215

Images BolBurg121Fa-b, BolObs2215Fa-e, BolObs2215La-e

Figure 5. (A) *Austroboletus* aff. *occidentalis* (B) *Fistulinella* aff. *prunicolor,* (C) *Clavulina* sp. A, (D) *Clavulina* sp. B, (E) *Podoscypha petalodes,* (F) *Punctularia strigosozonata,* (G) *Lactarius* aff. *sepiaceus* (H) *Lentinellus pulvinulus-hepatotrichus,* (I) *Russula clelandii,* (J) *Russula* aff. *cyanoxantha,* (K) *Exidia* sp. A (L) *Tremella* sp. A. Scale in some images is a white tag (23 x 13 mm) or a metal ruler with millimetre graduations.

Fistulinella mollis Watling

This particularly soft bolete (Chapter 2: Figure 8) has pink-buff pores and a pink spore print. Collections fit the description in Bougher and Syme (1998).

Macro-characters Pileus 35-85 mm; convex to plano-convex; pink-buff, buff, tan; soft, moist texture. Hymenium pores ~ 1 mm, irregularly spaced; pink-buff; pink spore print. Stipe 4-15 mm to 70 mm; off-white, buff; smooth.

Micro-characters Basidiospores 15.5-18.75 x 4-4.5 µm (x = 16.8 x 4.3 µm); narrowly fusiform; pale yellow-brown; smooth.

Collections SMF0130, SMF1154, SMF2239

Images BolMol1154f, BolMol1154L, Bol2239La-c

Fistulinella aff. *prunicolor* (Cooke & Massee) Watling

This bolete has a distinctive vinaceous tint to the fawn to sepia coloured cap (Figure 5). Collections fit the description of macro-characters but not the micro-characters in Watling and Gregory (1989).

Macro-characters Pileus 10-40 mm diam.; convex, trucate; fawn to vinaceous grey with vinaceous tints; viscid; margin is pale and often inrolled. Hymenium pores < 1 mm; irregularly spaced; off-white. Stipe up to 55 mm long, 5-12 mm diam. ; off-white; sometimes viscid; smooth.

Micro-characters Basidiospores 14.5-16.5 x 4.5-5.25 µm (x = 15.6 x 5 µm); narrowly fusiform to elongate ellipsoid; pale yellow-brown; smooth. Pleurocystidia present.

Collections SMF1050, SMF1153

Images BolBvin1050La-b, Bol1153f, BolVin1053L

Pisolithus aff. *arhizus* (Scop. : Pers.) Rauschert

This golden-black puff-ball is easy to recognise. *Pisolithus arhizus* is unlikely to occur in Australia, and this group probably contains a number of undescribed species. This taxon is considered here as having morphological character affinity to *Pisolithus arhizus* as depicted in Fuhrer (2005).

Macro-characters Irregularly pyriform fruit bodies, 10-50 mm diam.; golden, umber, balck with ochraceous tints. Flesh black with yellow, mustard, ochraceous rounded bundles. Stipe 30 mm high, 10-15 mm diam.; yellow to ochraceous; tapers towards base.

Collections	SMF1183, SMF2251
Images	Piso2251Fa, Piso2251La

Podoserpula pusio (Berk.) D.A.Reid

The pagoda-shaped or small shelved species has a central stem that is pale orange to pink and a wrinkled hymenium. This is a Fungimap target species (Grey and Grey 2005). No voucher was retained.

Xerocomus sp. A

This brown capped Bolete had a finely tomentose texture, and yellow pores and stipe. The collection fits the concept of *Xerocomus* in Singer (1986). This taxon was only found once and is treated here as a unique taxon.

Macro-characters Pileus up to 50 mm diam.; plano-convex; brown; finely tomentose texture. Hymenium pores >1.5 mm; irregular spacing; yellow, bruise blue. Stipe up to 55 mm long, 10 mm diam.; pale brown; dry.

Micro-characters	Basidiospores smooth.
Collections	SMF0123
Images	BoletBrY123Fa-b, BoletBrY123La

Cantharellales

Aphelaria sp. A

This taxon was distinctive by the cartilaginous texture and numerous fine branches. Collections matched the description for *Aphelaria* in Corner (1950).

Macro-characters Fruit-body to 35-60 mm high, branches 1-3 mm diam.; branches dirty cream, paler at the tips; tough, cartilaginous texture. Stipe distinct and dirty cream coloured.

Collections	SMF1508, SMF2105
Images	Clav1508La-b, Clav2105Fa-b, Clav2105La-b

Aphelaria sp. B

Like the taxon above, this has a cartilaginous texture, but was distinctive by the fan-like, webbed branches. The collection matched the description for *Aphelaria* in Corner (1950).

Macro-characters Fruit-body to 15-20 mm high, branches 1-2 mm diam.; pale brown branches folded and webbed, with broad, dirty cream coloured tips of branches; tough, cartilaginous texture. Stipe distinct and pale brown.

Collections Clav1581La-c

Images Clav1581La-c

Cantharellus concinnus Berk.

This small, decurrent, pale orange *Cantharellus* (Chapter 2: Figure 8) is easily distinguished when mature specimens are found. Mature specimens have less colour contrast between the cap and stem, being consistantly pale orange to salmon, but care needs to be taken with immature specimens which may be mistaken for *Hygrocybe* sp. B. The collection matches the description in Bougher and Syme (1998).

Macro-characters Pileus 10-30 mm diam.; hemispherical in juveniles becoming depressed in mature specimens; orange to salmon, with waxy shine; smooth, dry. Lamellae decurrent with many bifurcations; distant; pale orange. Stipe up to 32 mm long, 3-6 mm diam.; pale orange becoming paler at base; tapers downwards.

Micro-characters Basidiospores 8.25-10 x 5-6 µm (x = 9.2 x 5.5 µm); ellipsoid, pasesoliform, lacrymoid; hyaline with coarsely granular contents. Basidia has basal clamp connection.

Collections SMF1931

Images CanCin1931Fa-b, CanCin1931La-b

Clavulina redoleo-alii R.H. Petersen

This clavarioid taxon has pale clubs which were simple and had a strong garlic odour. The collection fits the description in Petersen (1988).

Macro-characters Fruit-body up to 80 mm high, 1-3 mm diam.; simple; clavate to fusiform; white, cream, buff, bone. Stipe indistict, concolorous. Strong garlic odour.

Micro-characters Basidiospores 7 x 6 µm; subglobose to broadly ellipsoid; hyaline; smooth. Basidia 4-spored.

Collections SMF0425

Images Clavwhite425L

Clavulina tasmanica (Berk. ex Cooke) Corner

This rough, dark clavarioid taxon matches the description in Petersen (1983).

Macro-characters Fruit-body up to 70 mm high, 2-6mm diam.; simple to very sparsely branched; clavate, narrowly spathiform, and some with few digitate to lobate branches; grey; vinaceous-grey, buff; irregular surface. Stipe indistinct; buff.

Collections SMF1490

Images ClavRugosa1490Fa-b, ClavRugosa1490La-b

Clavulina vinaceocervina (Cleland) Corner

This clavarioid taxon has distinctive ragged tips which are a burnt red colour. Characters match the description in Petersen (1983).

Macro-characters Fruit-body up to 100 mm high, branches <1-4 mm diam.; subsimple to irregularly branched; buff, vinaceous-buff, salmon, tips becoming burnt red colour; branches are irregular, often as short prongs. Stipe distinct, off-white to buff.

Micro-characters Basidiospores 7.5-8.5 x 6.5-7 µm; subglobse; hyaline; containing single large oil droplet. Basidia 2-spored. Cystidia present, cylindrical, slightly thick-walled.

Collections SMF1133, SMF2006

Images ClavRagFl1133L, Clav2006Fa, Clav2006La

Clavulina sp. A

This distictive taxon had pink, mauve to dark musk coloured clubs which were simple and had a strong garlic odour (Figure 5). This taxon did not match any of the species described in Petersen (1983) and so may be undescribed.

Macro-characters Fruit-body up to 110 mm high, 1-3 mm diam.; simple; clavate to fusiform; pink, mauve to dark musk. Stipe indistict, concolorous. Strong garlic odour.

Collections SMF1507

Images ClavPinGarlic1507La-b

Clavulina sp. B

This taxon was distinctive due to the creamy colours and branched fruit-body with sharp tipped branches and was found on soil (Figure 5). There are probably a

number of taxa which are macroscopically similar, but the four collections in this study had consistent set of microscopic characters so are considered a single undescribed taxon. This taxon was considered *Clavulina* due to the absence of cystidia and clamps, and the 2-spored basidia. All the other *Clavulinas* in this study were unbranched.

Macro-characters Fruit-bodies up to 35 mm high, branches <1-5 mm diam.; branched, arbuscular; cream, off-white, buff; tips of branches came to a point and there were several tips at the end of each branch. Stipe distinct, concolorous.

Micro-characters Basidiospores 7-8 x 6.5-7 µm (x = 7.7 x 6.9 µm); subglobose; hyaline; smooth; containing single oil droplet. Basidia 2-spored. Cystidia absent. Trama no clamps.

Collections SMF0346, SMF0437, SMF0453, SMF1503,

Images Clav346L, Clav437La-b, Clav453L, ClavWhRagid1503La-b

Hydnum repandum L. : Fr.

This soft cream taxon is easily recognised by the hymenium of cream teeth. This cosmopolitan species was recognised by the macro-characteristics, which fit the description in Maas-Geesteranus (1971).

Macro-characters Pileus 6-35 mm diam.; convex, planocovex with some specimens with depressed centres; cream, pale cream to pale yellow; smooth and dry surface. Hymenium dense teeth, <1 mm; cream. Stipe up to 35 mm long, 2-6 mm diam.; white to pale cream.

Collections SMF1991

Images HydRep1991Fa-b, HydRep1991La-c

Dacrymycetales

Calocera spp.

This orange-yellow gelatinous fungus has more distinctive shapes than the species of *Tremella*, with forms ranging from small lumps, to longer club shapes; these club shapes may have simple branches. This taxon was recognised based on its macroscopic features and has been lumped together at the level of genus.

Macro-characters Fruit-body 1-3 mm diam. to 10 mm high; club shaped, sometimes simple to blunt bifurcate tips, sometimes simply branched 1-5 tips; orange to yellow; gelatinous texture.

Collections	SMF0311, SMF2206
Images	Calo311La-b, Cal2206Fa-b, Cal2206La-c

Hymenochaetales

Coltricia cinnamomea (Jacq.) Murrill

This copper coloured species is distinctive due to the colour and the tough texture of the fruit-body. The collections match the description in Bougher and Syme (1998).

Macro-characters Pileus 15-40 mm diam.; plane to depressed; copper, bronze, orange-brown in concentric rings; radially velvet texture. Hymenium consisting of irregular pores <1 mm diam; buff to ochraceous. Stipe 2-7 mm to 30 mm long; dark orange-brown to umber; rough velvety.

Micro-characters	Basidiospores 7.75-9 x 5-5.25 µm (x = 8.1 x 5 µm).
Collections	SMF1140, SMF1601
Images	ColObl1140L, ColObl1601Fa-e, ColObl1601La-b

Phellinus wahlbergii (Fr.) D.A. Reid

This tough-woody chestnut-brown bracket was recognised by the macroscopic characters. The collection matches the macro-descriptions in Cunningham (1965), as *Phellinus zealandicus*, and in Hood (2003).

Macro-characters Pileus perennial; 60 mm ; applanate; chestnut-brown, umber; concentrically ridged; velvety. Hymenium poroid, pores < 5 mm diam.; chestnut-brown. Stipe absent.

Collections	SMF0410
Images	BracBvel410L

Phallales

Geastrum triplex Jungh.

This typical earthstar had 4-6 rays that were usually curled under the spore sac with a single, central collar-like mouth. No collections were made of this distinctive taxon. *Geastrum indicum* (Klotzsch) Rauschert as applied by Australian authors is the same taxon (May *et al.* 2004).

Ramariopsis bicolor R.H. Petersen

This delicate, branched, clavarioid taxon (Chapter 2: Figure 8) starts out yellow and becomes salmon coloured from the stipe upwards, due to the hysterochroic flesh, the tips remain yellow according to Petersen (1988). The collection fits the description in (Petersen 1983).

Macro-characters Fruit-body to 45 mm high, branches 1-2 mm diam.; tips and upper branches yellow, lower section salmon coloured. Stipe distinct and salmon coloured.

Micro-characters Basidiospores 3.75-4 x 2.5-3 µm (x = 3.8 x 2.6 µm); subglobose; hyaline; inamyloid; smooth;

Collections SMF1487

Images ClavYPi1487Fa-b, ClavYPi1487La-b

Ramariopsis corniculata (Schaeff. : Fr.) R.H.Petersen complex

This robust buff coloured *Ramariopsis* could easily be mistaken for a *Ramaria* but the microscopic characteristics place it firmly in *Ramariopsis.* Petersen (1988) discusses this complex when describing *R. alutacea*, which the collection does not fit despite having a similar spore range.

Macro-characters Fruit-body up to 60 mm high, branches 1-3 mm diam.; buff; tips blunt. Stipe distinct and buff.

Micro-characters Basidiospores 5.75-6.25 x 5-6 µm (x = 6 x 5.75 µm); globose to subglobose; hyaline, containing oil droplet; smooth. Basidia 4-spored, with basal clamp.

Collections SMF1541

Images RamBuff1541Fa-b, RamBuff1541La-b

Ramariopsis pulchella (Boud.) Corner

This delicate, purple, branched taxon (Chapter 2: Figure 8) may be confused with *Clavulina zollingeri* which is also branched and purple coloured. The microscopic characters of the collection confirm that this collection is a *Ramariopsis*, and match the description in Petersen (1978).

Macro-characters Fruit-body up to 50 mm high, branches <1-3 mm diam.; purple branches; tips pointed. Stipe distinct and buff coloured.

Micro-characters Basidiospores 3.5 x 3 µm; subglobose; finely spiney; hyaline. Basidia 4-spored with a basal clamp.

Collections SMF1505
Images RamViol1505Fa-b, RamViol1505La-b

Ramariopsis spp. I

This group contains branched taxa which were buff to cream in colour and were on the soil. This group contains at least two taxa considering the microscopic characters of the collections. These collections are thought to be *Ramariopsis* as they have clamps present in the trama.

Macro-characters Fruit-body up to 45 mm high, branches 1-5 mm diam.; cream, buff, off-white; branching irregularly but tips bifurcate. Stipe distinct and concolorous.

Micro-characters Basidia 4-spored. Trama clamps present.
Collections SMF0438, SMF1911
Images Clav438L, ClavWhit1911F, ClavWhit1911La-b

Ramaria lorithamnus (Berk.) R.H.Petersen

This pretty yellow *Ramaria* is distinctive due to the pure yellow colours with no hint of orange. The collection matches the description in Petersen (1988).

Macro-characters Fruit-body up to 80 mm high, branches 2-15 mm diam.; pure yellow to yellow. Stipe reduced and pale yellow.

Micro-characters Basidiospores 7-8 x 4.75-5 µm (x = 7.3 x 4.9 µm); ellipsoid; pale yellow (KOH); finely warty. Basidia 4-spored. Tramal clamps not seen.
Collections SMF1204
Images RamY1204fa-c, RamY1204L

Polyporales

Antrodiella citrea (Berk.) Ryvarden

This soft effused-reflexed polypore is easily regognised by the intense yellow of the upper surface. This can be easily recognised from the macrocharacters and matches the description in Buchanan and Ryvarden (2000).

Macro-characters Pileus 5-30 mm deep, and > 5 mm wide; effuse-reflexed; intense lemon-yellow to yellow, particularly at the margin. Pores <1 mm diam.; irregular spacing; white to off-white.
Collections SMF0323 , SMF1590

Images AntrHiY323L, AntrHiY1590Fa-c, AntrHiY1590La-b

Byssomerulius corium (Pers. : Fr.) Parmasto

This soft cream thelophore has a finely wrinkled hymenium. This matches the descriptions in Cunningham (1963) as *Meruliopsis corium* and Hood (2003).

Macro-characters Fruit-body thin, broad sheet or resupinate, cream to off-white all over, with soft texture. Hyemenium is finely wrinkled.

Micro-characters Hymenial layer contains cylindric, hyaline (KOH) terminal elements. Clamp connections not seen.

Collections SMF0459

Images MerCor459L

Corticiaceae spp. *sensu lato*

This is an artifical grouping of corticioid fungi which are flat patch or paint like fungi, which have textured surfaces for the hymenium. This is a particularly variable group in colour and texture. Looking at the images each collection may represent a different taxa.

Collections SMF0280, SMF0430, SMF0482, SMF0552, SMF1047, SMF2008, SMF2227

Images Paint280La-c, Patchpeach430La-b, PaintgreenP482L, Paint552L, PaintBl1047L, Paint2008Fa, Paint2008La-b, Patch2227Fa-b, Patch2227La-c

Fomitopsis lilacinogilva (Berk.) J.E.Wright & J.R.Deschamps

This lilac-pink polypore was distinctive as it had a broad attachment and a distinctive colour. The collection matches the macro-description in Hood (2003).

Macro-characters Pileus 10-1000 mm; shelf-like bracket, pad-like patch; lilac-pink near margin, orange-brown to yellow near attachment to wood; hirsute. Hymenium pores <2 mm diam.; lilac-pink, pale pink. Stipe absent.

Collections SMF1579

Images PolyPink1579Fa-d, PolyPink1579La-b

Podoscypha petalodes (Berk.) Pat.

This thelophore with a stem has a deeply infundibuliform pileus and is often found in large clusters (Figure 5). This species was recognised based on the macro-characters and matches the description in Cunningham (1963), as *Stereum elegans.*

Macro-characters Pileus 3-60 mm diam; deeply infundibuliform; concentric rings of colour red-brown in the centre, to tan and finally pale salmon to pale orange at margin, margin is often translucent. Hymenium is smooth to slightly wrinkled and a buff to pale salmon pink. Stipe to 20 mm high, 1-8 mm diam.; red-brown to tan; rough texture, often a disk at the base attaching to buried wood.

Collections SMF0016, SMF2229, SMF2257

Images Podpeta2229La-c, Podpet2257Fa-b, Podpet2257La-c

Punctularia strigosozonata (Schwein.) P.H.B.Talbot

This thelophore is distinctive as it has a pale brown-grey hymenium with a white bloom across the surface (Figure 5). This matches the description in Hood (2003).

Macro-characters Fruit-body thin, broadly attached shelf; brown to umber; with short hairy projections. Hyemnium pale brown/ grey colour with white bloom.

Micro-characters Hymenial layer contains paraphysate hyphae with are branched, sepatate and hyaline (KOH). Clamp connections present.

Collections SMF0390, SMF1972, SMF2003, SMF0375, SMF0479

Images Ster390L, Stec375L, Stec479L, Ster1972Fa-c, Ster1972La-c, Ster2003Fa-b, Ster2003La

Pycnoporus cinnabarinus (Jacq. : Fr.) P.Karst.

This bright orange tough polypore is easily recognised based on the macrocharacters alone, this matches the description in Bougher and Syme (1998).

Macro-characters Pileus 10-30 mm; semi-circular bracket; minutely fibrillose. Hymenium pores < 1 mm; bright orange. Stipe absent.

Collections SMF1020

Polypore sp. A

This tough red-brown capped polypore has a distinctive laterally stipitate form.

Macro-characters Pileus laterally stipitae; red-brown; tough; margin often forms a rim around the hymenium like the frame of a tennis racket. Hymenium pores < 1 mm diam., off-white. Stipe red-brown; tough texture.

Collections SMF0404, SMF0413

Images PolyRBC404a413L

Polypore spp.

This is an artificial grouping of all tough brackets with pores, other than the taxa described elsewhere in this Appendix. Considering the images each collection is probably a single taxon.

Collections SMF1158, SMF2101, SMF2252, SMF1304, SMF2205, SMF1982, SMF2014, SMF2015, SMF2022

Images Grif1158f-b, Grif1158L, Poly2101Fa-d, Poly2101La-d, Poly2252Fa, PolyCream1304Fa-b, PolyCream1304L, Poly2205Fa-d, Poly2205La-d, Poly1982Fa-e, Poly1982La-g, Poly2014Fa-c, Poly2014La-b, Poly2015Fa-b, Poly2015La-v, Poly2022La-c

Trametes versicolor (L. : Fr.) Lloyd

This polypore is distictive by the concentrically zoned cap surface. The collections match the macro-description in Cunningham (1965).

Collections SMF1575

Images TramVers1575Fa-c, TramVers1575La

Russulales

Artomyces spp.

These delicate, branching, clavarioid fungi found on wood were frequently observed. Despite recent revisions of Australian material (Wu *et al.* 1995; Lickey *et al.* 2003) the species reported from Australia are poorly separated, and therefore collections were only identified to genus.

Macro-characters Fruit-body regularly branching off-white, buff to fawn colours, multiple clusters on wood.

Collections SMF0350, SMF1054, SMF1935

Images Clav350La, ClavPip1054L, Clav1935Fa-c, Clav1935La-

c

Lactarius eucalypti O.K.Mill. & R.N.Hilton

This orange-brown mushroom is distinctive from its warm colour and white latex when cut. Collections fit the macrodescription in Bougher and Syme (1998).

Macro-characters Pileus 15-40 mm; depressed; bay brown in the centre to brick at margin; smooth. Lamellae adnate; close; rosy-buff. Stipe to 60 mm, 4-10 mm diam.; brick. White latex present.

Collections SMF1287

Images LactEuc1287Fa-b, LactEuc1287La

Lactarius aff. *sepiaceus* McNabb

This robust brown mushroom is hard to see amongst dark leaf litter, once noticed it has striking pale gills against the dark brown cap and stem (Figure 5). It produces a white viscid latex. The macrodescription fits the description in McNabb (1971), but as this collection was not found under *Nothofagus* as suggested, nor was it checked microscopically, it has been considered as a single taxon with affinity to *Lactarius sepiaceus*.

Macro-characters Pileus approx 52 mm diam; Planoconvex with slightly depressed centre; umber brown to karki brown; fine velvet to suede texture. Lamellae slightly decurrent; close; off-white. Stipe to 35 mm, 10-15 mm; umber brown to karki brown; fine velvet to suede texture. White latex present.

Collections SMF1913

Images Lact1913Fa-c, Lact1913La-b

Lentinellus pulvinulus-hepatotrichus complex

There are two species which make up this distinctive stemless, tough, rough gilled taxon (Figure 5). *Lentinellus pulvinulus* (Berk.) Pegler and *Lentinellus hepatotrichus* (Berk.) D.A.Reid are both found in the study area (Gates and Ratkowsky 2003). As all specimens seen were not collected this is being treated as a species complex.

Macro-characters Pileus 1-20 mm diam.; convex, fan-to kidney-shaped with eccentric attachment directly to; buff, cinnamon, sepia or, red-brown; often finely woolly, particularly near point of attachment, or may be smooth. Lamellae close; buff

to off-white; edge, ragged, eroded or serrate. Stipe absent, to very reduced, often woolly at point of attachment.

Micro-characters Basidiospores 4-6 x 2.25-4.5 µm (x = 5.2 x 3.3 µm); ellipsoid to subglobose.

Collections SMF0400, SMF0508, SMF1051, SMF1195, SMF2201

Images Lent400L, Lent508L, Lent1051L, Lent1195fa-b, Lent1195L, Lent2201Fa-d, Lent2201La-b

Mucronella pendula (Massee) R.H.Petersen

This coral fungus was found on wood and is easily distinguished by its pale 'icicle-shaped' form. This is a Fungimap target species (Grey and Grey 2005). No voucher was retained.

Russula clelandii O.K.Mill. & R.N.Hilton complex

Russulas which had red to purple colours in the cap, and often blushes on the stem, but with white gills with no yellow tints were grouped together in the field (Figure 5). Collections fit the macrodescription of *Russula clelandii* in Bougher and Syme (1998), this group probably represents a complex of taxa.

Macro-characters Pileus 15-40 mm; hemispherical to planoconvex; orange-pink with yellow-black centre. Lamellae adnexed; white. Stipe 5-10 mm to 35 mm.

Collections SMF1131, SMF2238

Images RusPurY1131L, Rus2238La-b

Russula aff. cyanoxantha (Schaeff.) Fr.

This is a particularly variable taxon, the gills and stipe are consistently a cream to pale yellow colour but the cap has variable patches of cream, grey, yellow, and maroon (Figure 5). Collections matched the macrodescription in Bougher and Syme (1998), this probably represents a single taxon with affinities to *Russula cyanoxantha*.

Macro-characters Pileus 30-80 mm ; convex to hemispherical, depressed; rosy buff, bay to rust with pale yellow to buff background; dry, with fine warty texture with cracks in flesh. Lamellae free to adnate; close; pale yellow to white. Stipe 8-20 mm to 35-80 mm; dry; pale yellow to off-white.

Collections SMF1199, SMF1337

Images RusPale1199L, PlumCust1337Fa-b

Russula erumpens Cleland & Cheel

This distinctively shiny-capped Russula, has colours that are dirty cream becoming brown in patches with age and handling. Collections match the macrodescription in Bougher and Syme (1998).

Macro-characters Pileus up to 100 mm diam.; depressed; dirty cream to brown in centre to pale cream at margin; shiny and viscid cap; discolours brown with handling. Lamellae adnexed; close; white, discolours brown in patches. Stipe 18 mm to 45 mm; white. Odour unpleasant.

Collections SMF2267

Images Rus2267Fa, Rus2267La-b

Russula neerimea Grgur.

The yellow-brown capped Russula consistently had a translucent striate, grooved margin. Collections matched the macrodescription of *Russula neerimea* in Bougher and Syme (1998).

Macro-characters Pileus 60-100 mm; depressed; pale ochraceous to buff; furrowed at margin and translucent striate. Lamellae adnate; coles; off-white. Stipe to 80 mm, 10-15 mm; offwhite; tapering towards base.

Collections SMF1485, SMF2266

Images RusPale1485Fa-c, RusPale1485La-b, Rus2266Fa-c, Rus2266La-b

Russula purpureoflava Cleland

Russulas which had red to purple colours in the cap, and often blushes on the stem, and with pale yellow tints to the gills, stem and flesh were grouped together in the field. Collections matched the macrodescription of *Russula purpureoflava* in Grgurinovic (1997).

Macro-characters Pileus 30-80 mm; depressed; livid purple, vinaceous purple, vinaceous; opaque, some specimens glutinous. Lamellae adnate, close to crowded; pale yellow to primrose. Stipe to 70 mm, 8-20 m ; primrose near lamellae, with rosy vinacous to coral blush on lower stipe.

Collections SMF1159

Images RusYRP1159fa-b

Stereales spp.

These have resupinate to applanate sporophores. This is an artifical grouping of Corticioid fungi which had smooth hymenial surfaces but where not *Punctularia strigosozonata, Stereum hirsutum*, or *S.illudens.*

Collections SMF1569, SMF1577

Images Stervel1569Fa-c, Stervel1569L, SterConvB1577Fa-b, SterConvB1577La-b

Stereum hirsutum (Willd. : Fr.) Pers.

This theleophore has a distinctive ochraceous hymenium (Chapter 2: Figure 9). This matches the description in Cunningham (1963).

Macro-characters Fruit-body thin, broadly attached shelf; 5-30 mm diam.; ochraceous, buff, pale yellow; radially hirsute projections. Hymenium ochraceous.

Micro-characters Hymenial layer contains terminal elements some are cylindric, thick walled, and the other elements with are acuminate with septae.

Collections SMF1046, SMF1412, SMF1450, SMF1555, SMF1578

Images Ster1046La-b, Ster1412L-b, Ster1555Fa-b, Ster1555La-b, Ster1578Fa-b, Ster1578La-b

Stereum illudens Berk.

This has a distinctive pink, brown with purple tint to the hymenium that is distinctive. This matches the description in Cunningham (1963).

Macro-characters Fruit-body thin, broadly attached shelf; 5-40 mm diam; brown, often concentrically zoned; short hairy projections. Hyemneium pink to brown with purple tint.

Micro-characters Acanthophysoids present.

Collections SMF0295

Tremellales

Exidia sp. A

This gelatinous taxon ranges from pale grey to umber brown, and has clear glandular warts which makes it distinctive (Figure 5) from the other gelatinous taxa described herein. This genus may be a new record for Tasmania.

Macro-characters Fruit-body attaches to in lobed to folded patches; 5-30 mm across to 2-5 mm; pale grey to umber brown; gelatinous texture, with small glandular warts.

Micro-characters Basidiospores 12.5-18 x 5-6 µm (x = 14.2 x 5.7 µm); bacilliform to allantoid.

Collections SMF1976

Images Exid1976Fa-c, Exid1976La-c

Heterotextus peziziformis (Berk.) Lloyd

This bell-shaped gelatinous orange fungus is very distinctive. Two species are recorded from Australia (May *et al.* 2003). McNabb (1965) considers two macroscopically similar taxa: *H. peziziformis* and *H. miltinus*. Collections may have been immature as spore range is smaller than either species described and sepatation was very variable. This taxon was recognised based on the macroscopic characteristics.

Macro-characters Fruit-body 2-10 mm diam.; bell-shaped with broad stem-like attachment; scattered to gregarious; translucent orange; gelatinous texture.

Micro-characters Basidiospores 11-13.2 x 5-6.6 µm; cylindric, curved; both sepatae and aseptate spores seen; smooth.

Collections SMF0531, SMF1605, SMF1963

Images HetPezAlpFa, HetPez1963Fa-b, HetPez1963La-b

Pseudohydnum gelatinosum (Scop. : Fr.) P.Karst.

This distinctive gelatinous hydnoid taxon is unique. Collections match the description in Breitenbach and Kranzlin (1986). This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Pileus 10-25 mm diam.; convex, umber to pale umber; soft velvet texture. Hymenium gelatinous with hydnoid spines; translucent grey to

white. Stipe absent or reduced, fruit-body usually broadly and laterally attached to substrate.

Collections SMF1910

Images PseuGel1910Fa-b

Tremella mesenterica Retz. & Fr. complex

These bright yellow to orange gelatinous lumps are folded, often looking like gelatinous brains. The *Tremella mesenterica* complex includes *T. aurantia* Schwein. : Fr., which is macroscopically similar, but differs in spore dimensions (Roberts 1995).

Macro-characters Fruit-body 10-90 mm; hemispherical to irregular lumps with many folds; yellow to orange; gelatinous texture.

Micro-characters Basidiospores 7.75-11 x 7.25-9 µm (x = 9.1 x 7.9 µm); subglobose, granular contents; hyaline (KOH).

Collections SMF1568

Images Trem1568Fa-d, Trem1568La-c

Tremella fuciformis Berk.

This translucent, white, gelatinous fungus is very distintive. This taxa was recognised based on the macroscopic characteristics. This is a Fungimap target species (Grey and Grey 2005).

Macro-characters Fruit-body 3-10 mm diam.; irregular, folded lumps; white, translucent; gelatinous texture.

Collections SMF1220

Images TremFuc1220L

Tremella sp. A

These small orange-yellow translucent gelatinous lumps are distinct from *Calocera* spp. as these are never longer than wide and so do not become club shaped (Figure 5). Although the same colour and texture as *Tremella aurantia* and *T. mesenterica*, these are never larger than 7 mm in diameter and although irregular in outline are not folded. This taxon was based on the macroscopic characteristics and probably represents an undescribed taxon. This was consistently observed on burnt wood.

Macro-characters Fruit-body 1-5 mm diam.; irregular lumps sometimes with slight stem; often caespitaose along the grain of the wood; yellow, orange, honey, amber; gelatinous texture.

Collections SMF1045, SMF1567, SMF2220

Images Trem1045L, TremJellyLump1567Fa-c, TremJellyLump1567La-c, Trem2220Fa-c, Trem2220La-b

Thelephorales

Hydnellum sp. A

This tough brown taxon has a spiny or toothed hymenium, which distinguishes it from *Coltricia cinnamomea* or a stipitate Polypore, which it somewhat resembles on first glance. Upon closer inspection the hydnoid hymenium makes it unmistakable. The lack of clamps in the trama and the angular spores with warty projections match the genus concept in Maas-Geesteranus (1971).

Macro-characters Pileus 10-50 mm diam.; depressed to infundibuliform, often irregular; has concentric zones grading from sepia in the centre, fawn, to vinacous buff; finely vetvet texture. Hymenium spines <1 mm; vinacous buff to fawn. Stipe 4-15 mm to 40 mm; tough; sepia to fawn.

Micro-characters Basidiospores 4.5 x 3.5 µm; angular with very small warty projections. Clamp connections absent on spine trama.

Collections SMF0266, SMF1294

Images HydoidB266L, HydoidB1294F, HydoidB1294L

Myxomycota

Physarales

Fuligo septica (L.) Wiggers

This blob-like mass is distinctive amongst the leaf litter. The colour ranges from off-white, pink to bright yellow. This is a Fungimap target species (Grey and Grey 2005). No voucher material was retained.

Macro-characters Fruit-body 10-50 mm diam.; yellow, off-white, pink.

Images SlimeMouldFa-b

References

Bas C, Kuyper TW, Noordeloos ME, Vellinga EC, van Crevel R, van Os J (1995) 'Flora Agaricina Neerlandica 3.' (A.A.Balkema: Rotterdam)

Bougher NL, Syme K (1998) 'Fungi of Southern Australia.' (University of Western Australia Press)

Breitenbach J, Kranzlin F (1984) 'Fungi of Switzerland - Vol 1 Ascomycetes.' Fungi of Switzerland (Verlag Mykologia, Switzerland)

Breitenbach J, Kranzlin F (1986) 'Fungi of Switzerland, Volume 2: Non Gilled Fungi.' (Verlag Mykologia: Lucerne)

Brodie HJ (1975) 'The bird's nest fungi.' (University of Toronto Press: Toronto)

Buchanan PK, Ryvarden L (2000) New Zealand polypore fungi: six new species and a redetermination. *New Zealand Journal of Botany* **38**, 251-263.

Corner EJH (1950) A monograph of Clavaria and allied genera. *Annals of Botany Memoirs* **1**, 1-740.

Cunningham GH (1963) 'The Thelephoraceae of Australia and New Zealand.' (Government Printer: Wellington)

Cunningham GH (1965) 'Polyporaceae of New Zealand.' (Government Printer: Wellington)

Dennis RWG (1958) Critical notes on some Australian Helotiales and Ostropales. *Kew Bulletin* **13**, 321-.

Fuhrer B (2005) 'A field guide to Australian Fungi.' (Bloomings Books: Melbourne)

Gasparini B (2001) A contribution to the knowledge of *Cortinarius* and allied genera of southern Tasmania, Australia 1. *Cortinarius* subgenus *Cortinarius*. *Australasian Mycologist* **20**, 49-54.

Gates G, Ratkowsky DA (2003) The Fungal genus *Lentinellus* in Tasmania. *The Tasmanian Naturalist* **125**, 9-13.

Gates G, Ratkowsky DA (2005) A preliminary census of the macrofungi of Mt Wellington, Tasmania - the Ascomycota. *Papers and Proceedings of the Royal Society of Tasmania* **139**, 49-52.

Grey P, Grey E (2005) 'Fungi down under.' (Fungimap: Melbourne)

Grgurinovic CA (1997) 'Larger Fungi of South Australia.' (Botanic Gardens of Adelaide and State Herbarium: Adelaide, South Australia)

Grgurinovic CA (2002) 'The genus *Mycena* in south-eastern Australia.' (Fungal Diversity Press and Australian Biological Resources Study: Canberra)

Grgurinovic CA (2003) 'The Genus *Mycena* in South-eastern Australia.' (Fungal Diversity Press and Australian Biological Resources Study: Canberra)

Halling RE (2004) Gymnopus - Section Levipedes. In 'Collybia s.l. in NE United States & Canada'. (Ed. RE Halling) (The New York Botanical Garden: Bronx, NY) http://www.nybg.org/bsci/res/col/index.html.

Hood IA (2003) 'An introduction to fungi on wood in Queensland.' (University of New England: Armidale)

Horak E (1973) Fungi agaricini Novaezelandiae I-V. *Nova Hedwegia Beheifte* **43**, 1-200.

Horak E (1977) The genus *Melanotus* Pat. *Persoonia* **9**, 305-327.

Horak E (1978) *Pleuroflammula*. *Persoonia* **9**, 439-451.

Horak E (1980a) Entoloma (Agaricales) in Indomalaya and Australasia. *Nova Hedwegia Beheifte* **65**, 1-352.

Horak E (1980b) Fungi agaricini Novaezelandiae X. Simocybe Karsten. *New Zealand Journal of Botany* **18**, 189-196.

Kirk PM, Cannon PF, David JC, Stalpers JA (2001) 'The Dictionary of the Fungi.' (CAB International: Wallingford, Oxon)

Lickey EB, Hughes KW, Petersen RH (2003) Phylogenetic and taxonomic studies in Artomyces and Clavicorona (Homobasidiomycetes: Auriscalpiaceae). *Sydowia* **55**, 181-254.

Maas-Geesteranus RA (1971) 'Hydnaceous Fungi of the Eastern Old World.' (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen.)

May TW (1989) Report on FNCV Fungal Excursions : 1986 - 1988. *Victorian Naturalist* **106**, 48-58.

May TW, Milne J, Shingles S, Jones RH (2003) 'Fungi of Australia 2B - Catalogue and Bibliography of Australian Fungi 2. Basidiomycota p.p. and Myxomycota p.p.' Fungi of Australia (ABRS Australia: Canberra)

May TW, Milne J, Wood AE, Shingles S, Jones RH, Neish P (2004) Interactive Catalogue of Australian Fungi Version 2.0 In http://www.rbg.vic.gov.au/research_and_conservation/fungi/cat. (Australian Biological Resources Study, Canberra / Royal Botanic Gardens Melbourne)

McKenzie EHC, Buchanan PK, Johnston PR (2000) Checklist of fungi on *Nothofagus* species in New Zealand. *New Zealand Journal of Botany* **38**, 635-720.

McMullan-Fisher SJM, May TW, Kirkpatrick JB (2003) Some macrofungi from alpine Tasmania. *Australasian Mycologist* **22**, 44-52.

McNabb RFR (1965) Taxonomic studies in the Dacrymycetaceae V: Heterotexus Lloyd. *New Zealand Journal of Botany* **3**, 215-222.

McNabb RFR (1971) The Russulaceae of New Zealand 1. Lactarus DC ex S.F. Gray. *New Zealand Journal of Botany* **9**, 46-66.

Pegler DN, Laessoe T, Spooner B (1995) 'British Puffballs, earthstars and stinkhorns.' (Royal Botanic Gardens, Kew: London)

Petersen RH (1978) The genus *Ramariopsis* in south-eastern Australia. *Australian Journal of Botany* **26**, 425-431.

Petersen RH (1979) Notes on clavarioid fungi. XVII *Clavulinopsis* taxa in southeastern Australia. *Sydowia* **XXXII**, 209-223.

Petersen RH (1983) Notes on clavarioid fungi. XVIII. A Preliminary outline of *Clavulina* in Southeastern Australia. *Nova Hedwegia* **37**, 19-35.

Petersen RH (1988) 'The clavarioid fungi of New Zealand.' (Science information publishing centre: Wellington)

Rees BJ, Orlovish DA, Marks PB (1999) Treading the fine line between small-statured *Gymnopilus* and excentrically stipitate *Galerina* species in Australia. *Mycological Research* **103**, 427-442.

Rees BJ, Strid A (2001) Relationships between Australian and northern hemisphere *Gymnopilus* species 1: New species and common misconceptions regarding earlier names. *Australasian Mycologist* **20**, 29-48.

Rifai MA (1968) 'The Australasian pezizales in the herbarium of the Royal Botanic Gardens Kew.' (N.V. Noord-Hollandsch Uitgevers Maatschappij: Amsterdam)

Singer R (1986) 'The Agaricales in Modern Taxonomy.' (Koeltz Scientific Books: Koenigstein)

Spooner B (1987) 'Helotiales of Australasia : Geoglossaceae, Orbiliaceae, Sclerotiniaceae, Hyaloscyphaceae.' (J. Cramer: Berlin, Stuttgart)

Watling R, Gill M, Gimenez A, May TW (1992) A new styrylpyrone- containing *Cortinarius* from Australia. *Mycological Research* **96**, 743-748.

Watling R, Gregory NM (1986) Observations on the Boletes of the Cooloola Sandmass, Queensland and Notes on their Distribution in Australia. *Proceedings of the Royal Society of Queensland* **97**, 97-128.

Watling R, Gregory NM (1989) Observations on the Boletes of the Cooloola Sandmass, Queensland and Notes on their Distribution in Australia Part 2C. Smooth Spored Taxa - Strobilomycetaceae. *Proceedings of the Royal Society of Queensland* **100**, 13-30.

Wood AE (1997) Studies in the genus *Amanita* (Agaricales) in Australia. *Australian Systematic Botany* **10**, 723-854.

Wood AE (2001) Studies in the Genus *Galerina* (Agaricales) in Australia. *Australian Systematic Botany* **14**, 615-676.

Wu Q, Hughes KW, Petersen RH (1995) A reevaluation of taxa of Clavicorona subg. Ramosa based on morphology, compatibility, and laccase electrophoretic patterns. *Sydowia* **47**, 89-124.

Young AM (1999) A field key to the Hygrophoraceae of south-eastern Australia. *Australasian Mycologist* **18**, 63-69.

Young AM (2000a) Additions to the Hygrocybeae (Fungi, Hygrophoraceae) of Victoria. I. *Muellaria* **14**, 51-64.

Young AM (2000b) Additions to the Hygrophoraceae (Fungi, Agaricales) of south-eastern Australia. *Muellaria* **13**, 1-36.

Young AM (2000c) *Hygrocybe kula* Grgur. revisited. *Australasian Mycologist* **19**, 91-95.

Young AM (2001a) Further Hygrophoraceae of Victoria. *Australasian Mycologist* **20**, 115-117.

Young AM (2001b) Profiles of Fungi: *Hygrophorus involutus* and *Hygrocybe graminiclor*. *Mycologist* **15**, 36-38.

Young AM (2002) *Hygrocybe boothii* sp. nov., from northern Queensland. *Australasian Mycologist* **21**, 73-75.

Young AM, Bougher NL, Robinson RM (2000) Hygrophoraceae of Western Australia II. Further Taxa. *Australasian Mycologist* **19**, 41-48, 78.

Young AM, Mills AK (2002) The Hygrophoraceae of Tasmania. *Muellaria* **16**, 3-28.

Young AM, Wood AE (1997) Studies on the Hygrophoraceae (Fungi, Holobasidiomycetes, Agaricales) of Australia. *Australian Systematic Botany* **10**, 911-1030.

Appendix 5. Autocorrelation results

There were significant associations found between the biotic assemblages and geographic distance on the biotic assemblages (Table 1), environmental distance (Table 2) and for the combination of geographic and environmental distances (Table 3). The difference between the environmental distance mantel test with the combined geographic and environmental distance tests had the identical r-values but there is a slight change in the 95% confidence interval. When Partial mantel tests were run, accounting for the effect of the relative distances between sites, the resulting relationships between the biotic groups and environmental variables were still significant but the relative r-values were reduced (Table 4).

Table 1 Mantel tests between biotic groups and a geographic distance matrix. CI = Confidence interval. Probability (P) =< 0.0001 for all tests.

Matrices	r ± 95% CI
Plants - Geographic	0.6231 ± 0.0724
Mosses - Geographic	0.4775 ± 0.0922
Macrofungi - Geographic	0.4618 ± 0.0994

Table 2 Mantel tests between biotic groups and environmental variables matrix. CI = Confidence interval. Probability (P) =< 0.0001 for all tests.

Matrices	r ± 95% CI
Plants - Environment	0.8039 ± 0.0835
Macrofungi - Environment	0.6987 ± 0.0835
Mosses - Environment	0.6735 ± 0.0836

Table 3 Mantel tests between biotic groups and geographic distance and environmental variables combined matrix. CI = Confidence interval. Probability (P) =< 0.0001 for all tests.

Matrices	r ± 95% CI
Plants - Geographic + Environment	0.8039 ± 0.0837
Macrofungi - Geographic + Environment	0.6987 ± 0.0837
Mosses - Geographic + Environment	0.6735 ± 0.0837

Table 4 Partial Mantel tests between biotic groups with environmental variables matrix with geographic distance as the stable matrix. CI = Confidence interval. Probability (P) =< 0.0001 for all tests.

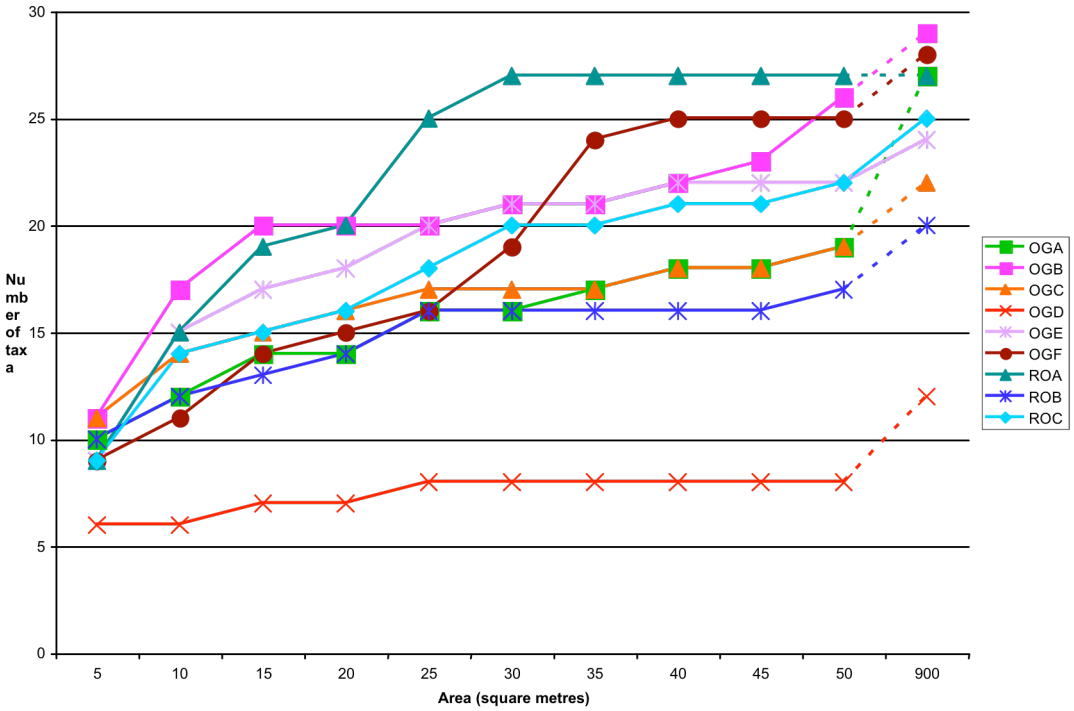
Matrices	r ± 95% CI
Plants - Environment	0.7753 ± 0.0806
Macrofungi - Environment	0.6351 ± 0.0877
Mosses- Environment	0.6018 ± 0.0864

Appendix 6. Area accumulation curves for vascular plants, mosses, macrofungi and successive intensive macrofungal figures.

Species accumulation curves

Area accumulation curves

Figure 1. Cumulative numbers of vascular plants by area from wet forest



sites (site names Chapter 2, Table 1).

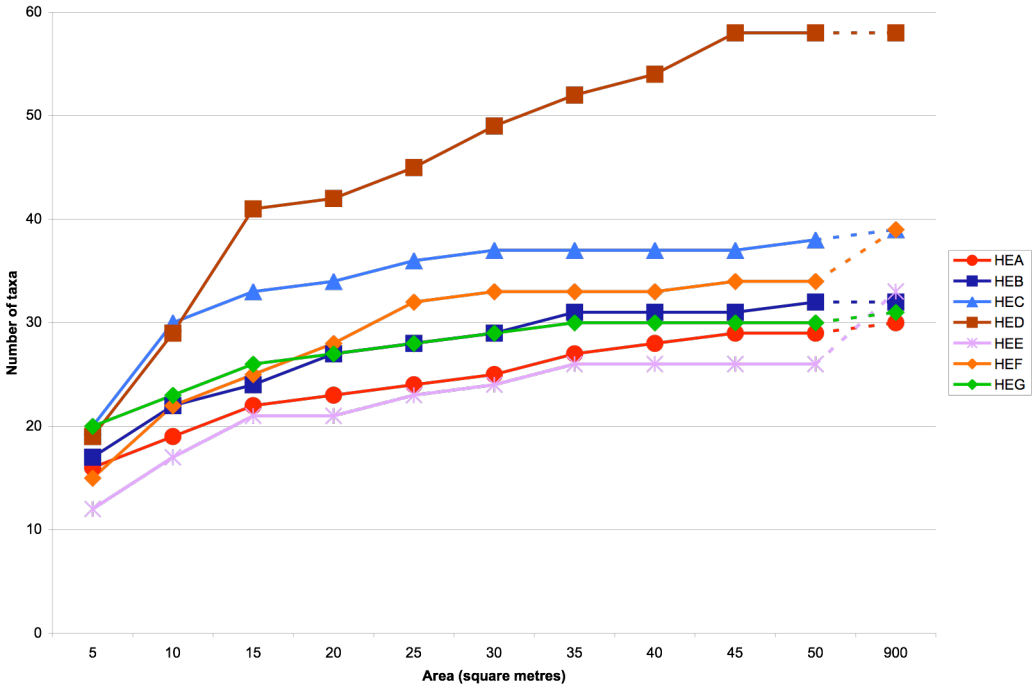


Figure 2. Cumulative numbers of vascular plants by area from heathy woodland sites (site names Chapter 2, Table 1).

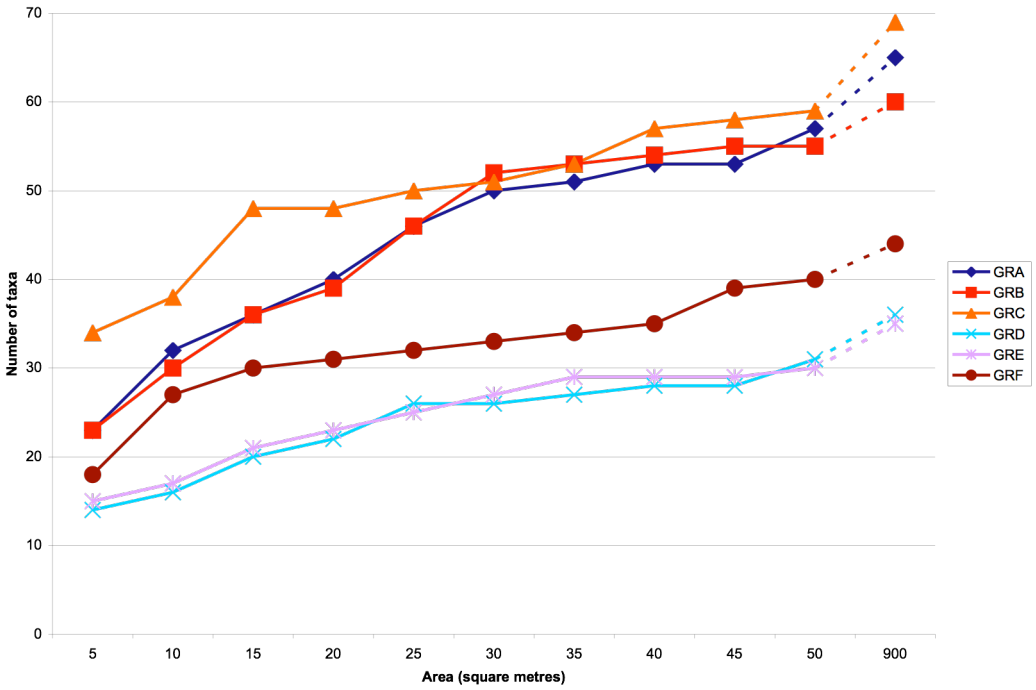


Figure 3. Cumulative numbers of vascular plants by area from grassy woodland sites (site names Chapter 2, Table 1).

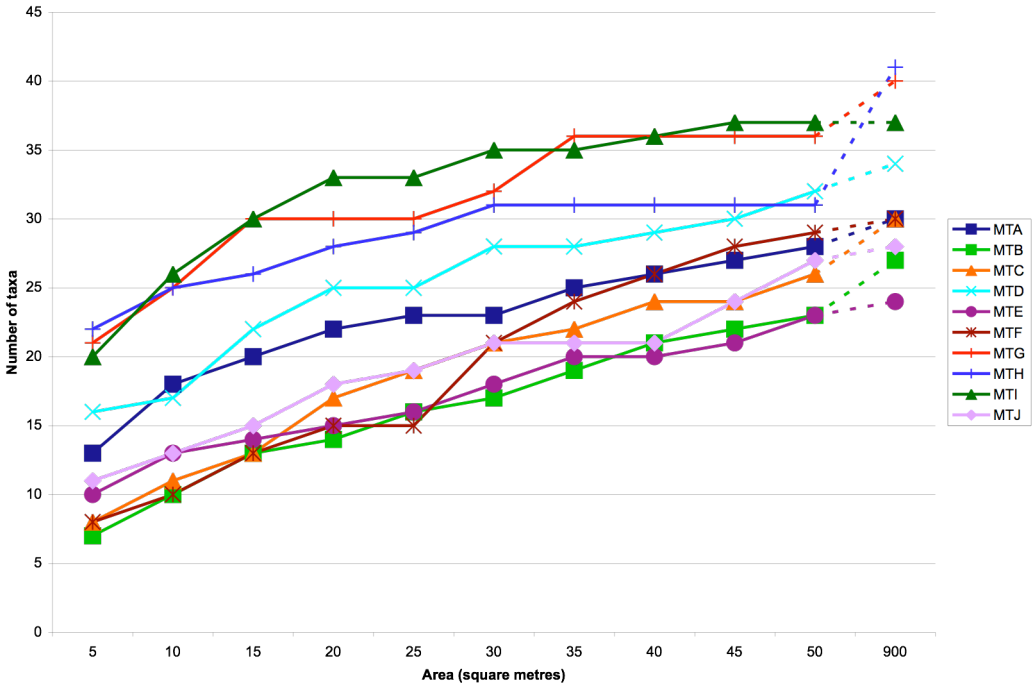


Figure 4. Cumulative numbers of vascular plants by area from alpine heath sites (site names Chapter 2, Table 1).

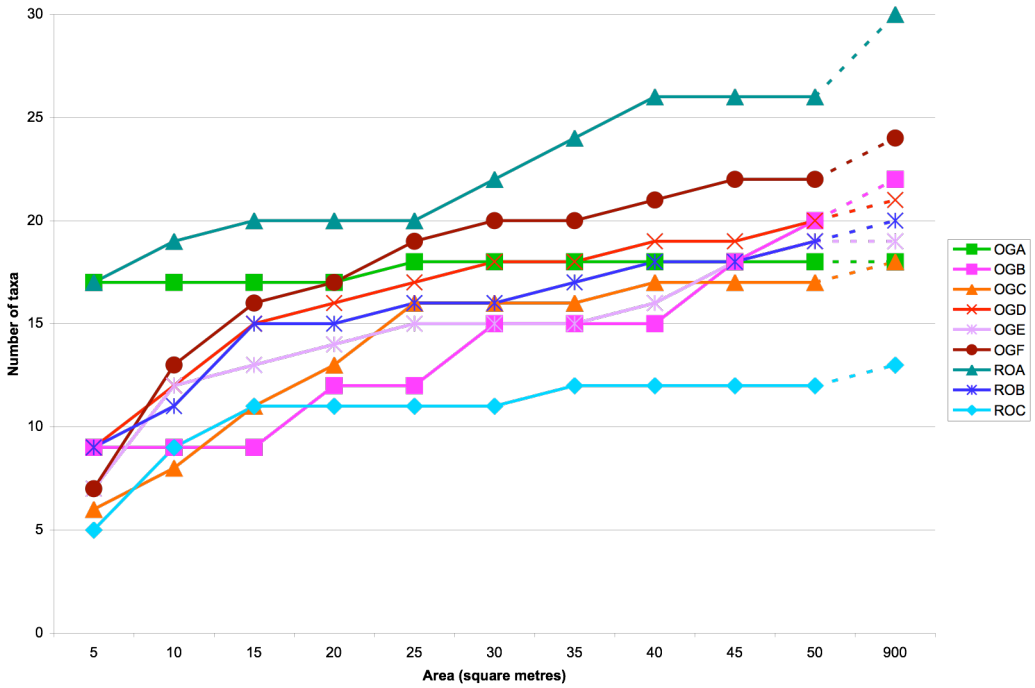


Figure 5. Cumulative numbers of mosses by area from wet forest sites (site names Chapter 2, Table 1) including short and total plot surveys.

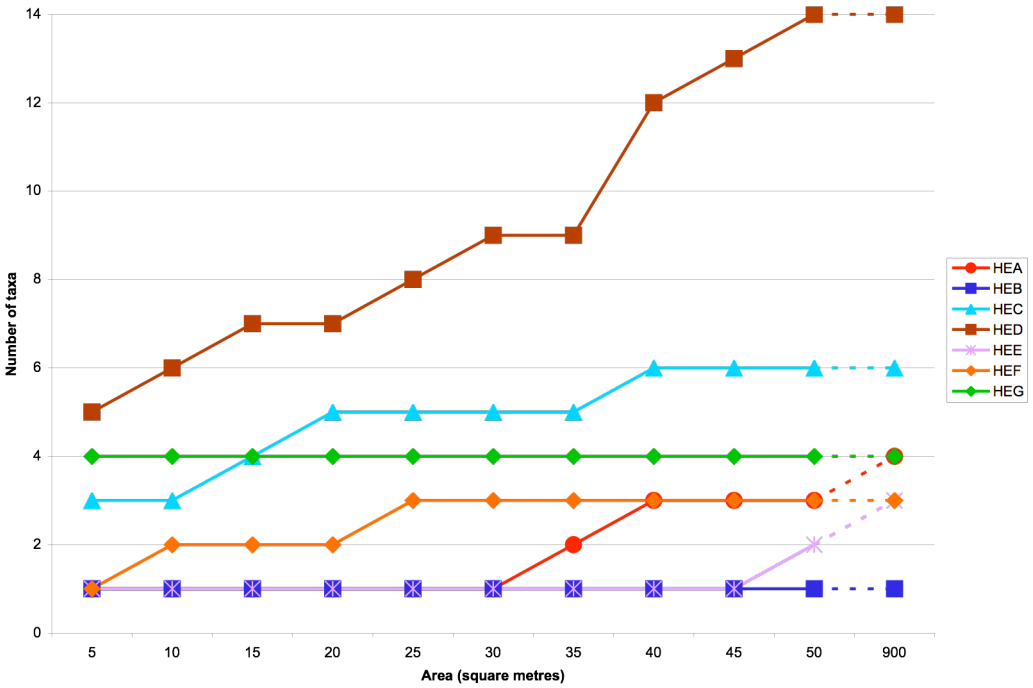


Figure 6. Cumulative numbers of mosses by area from heathy woodland sites (site names Chapter 2, Table 1) including short and total plot surveys.

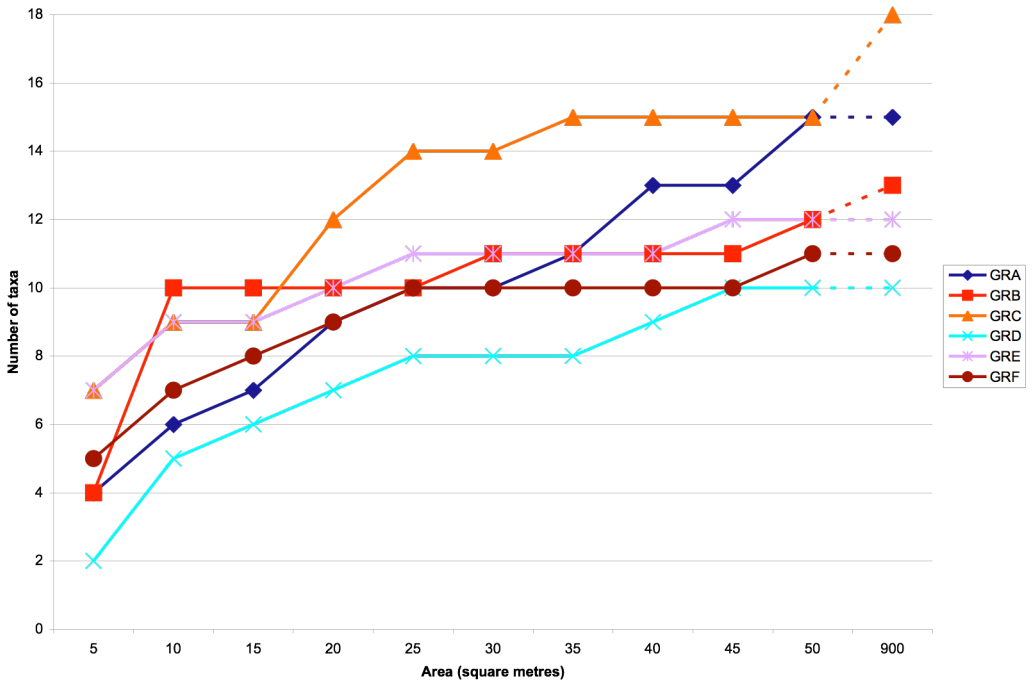


Figure 7. Cumulative numbers of mosses by area from grassy woodland sites (site names Chapter 2, Table 1) including short and total plot surveys.

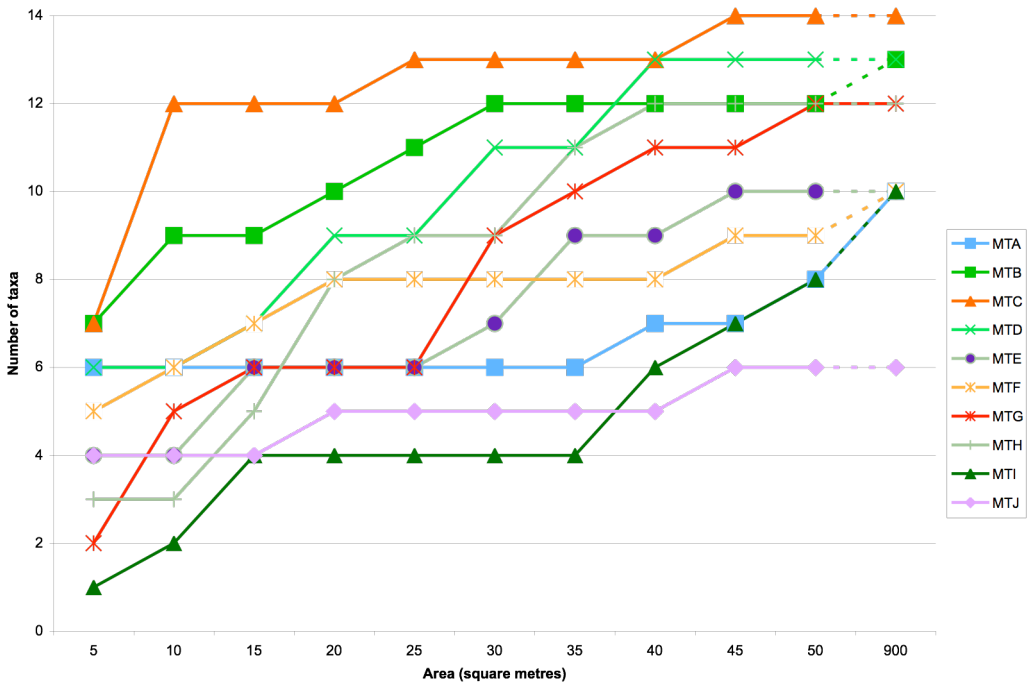


Figure 8. Cumulative numbers of mosses by area from alpine heath sites (site names Chapter 2, Table 1) including short and total plot surveys.

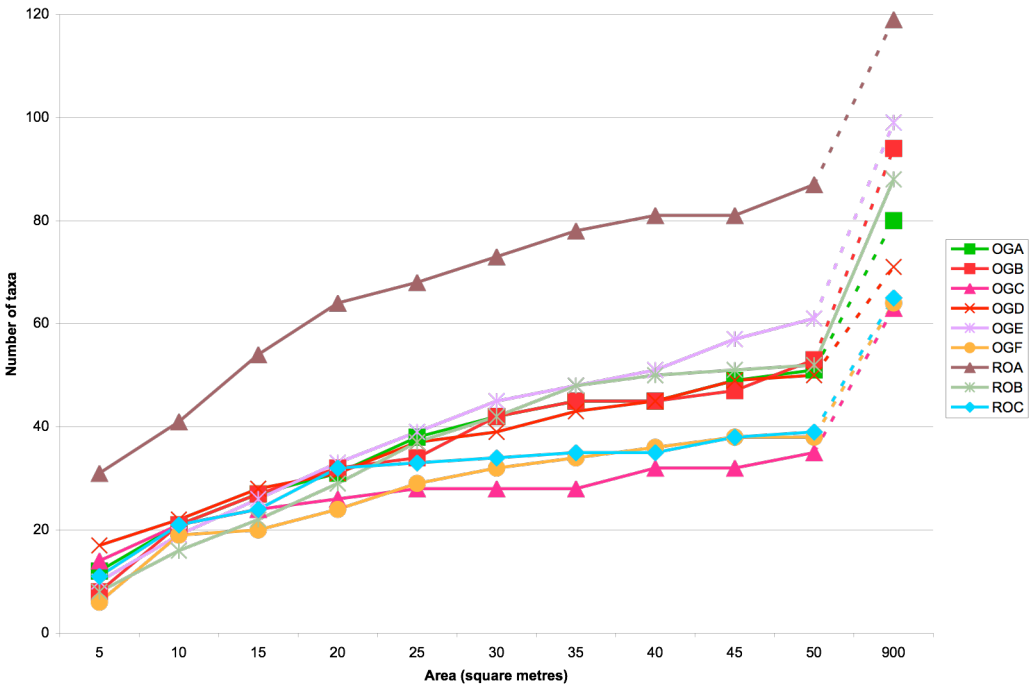


Figure 9. Cumulative numbers of macrofungi by area from wet forest sites (site names Chapter 2, Table 1) including all surveys.

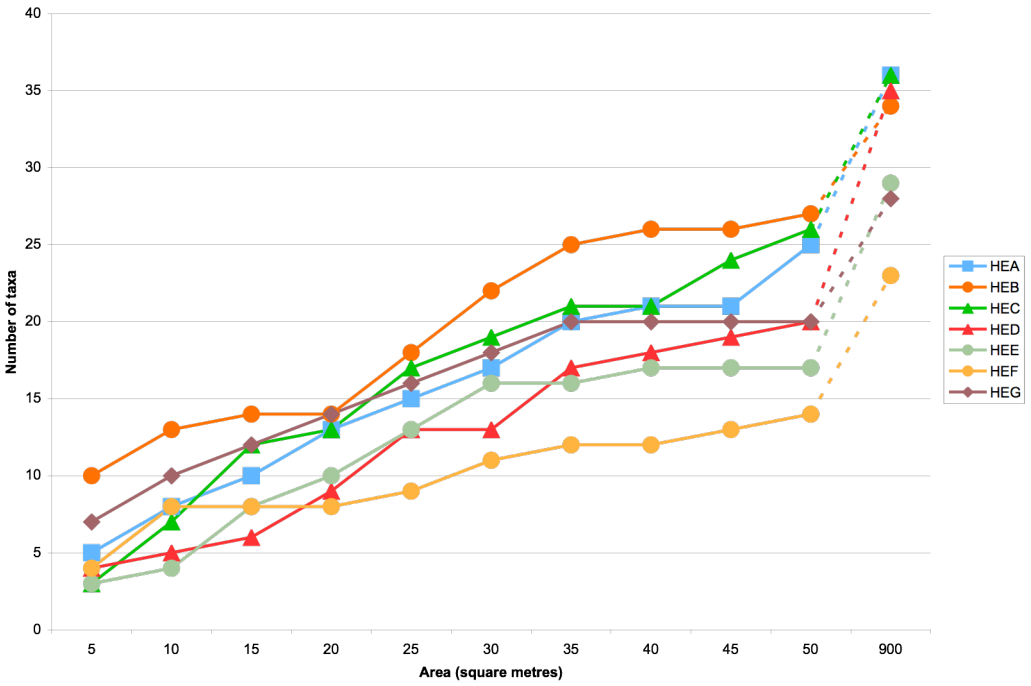


Figure 10. Cumulative numbers of macrofungi by area from heathy woodland sites (site names Chapter 2, Table 1) including all surveys.

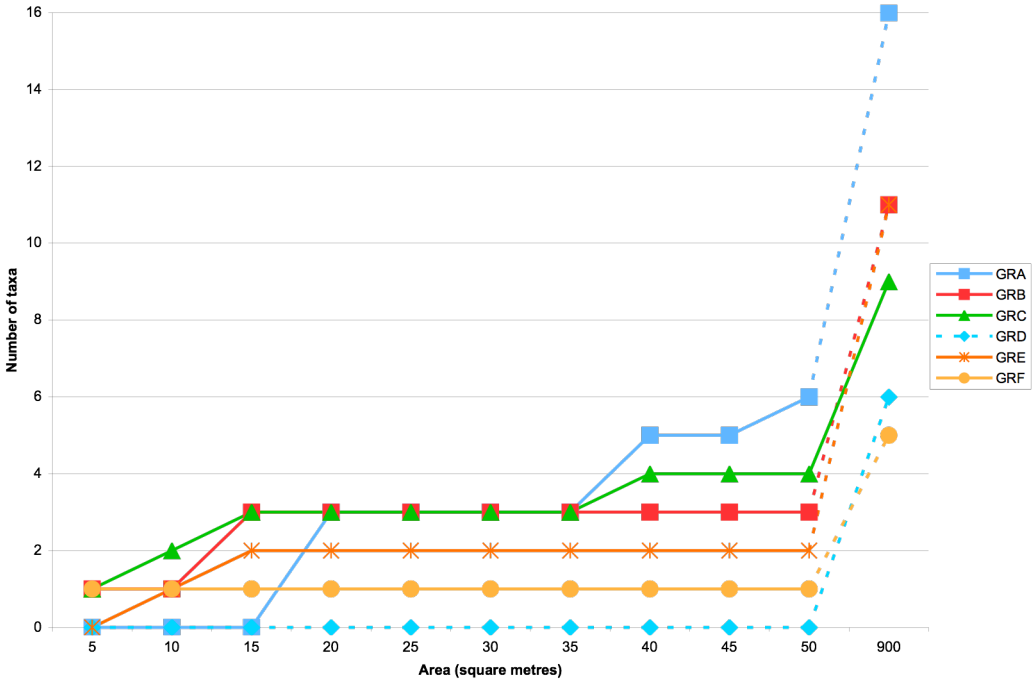


Figure 11. Cumulative numbers of macrofungi by area from grassy woodland sites (site names Chapter 2, Table 1) including all surveys.

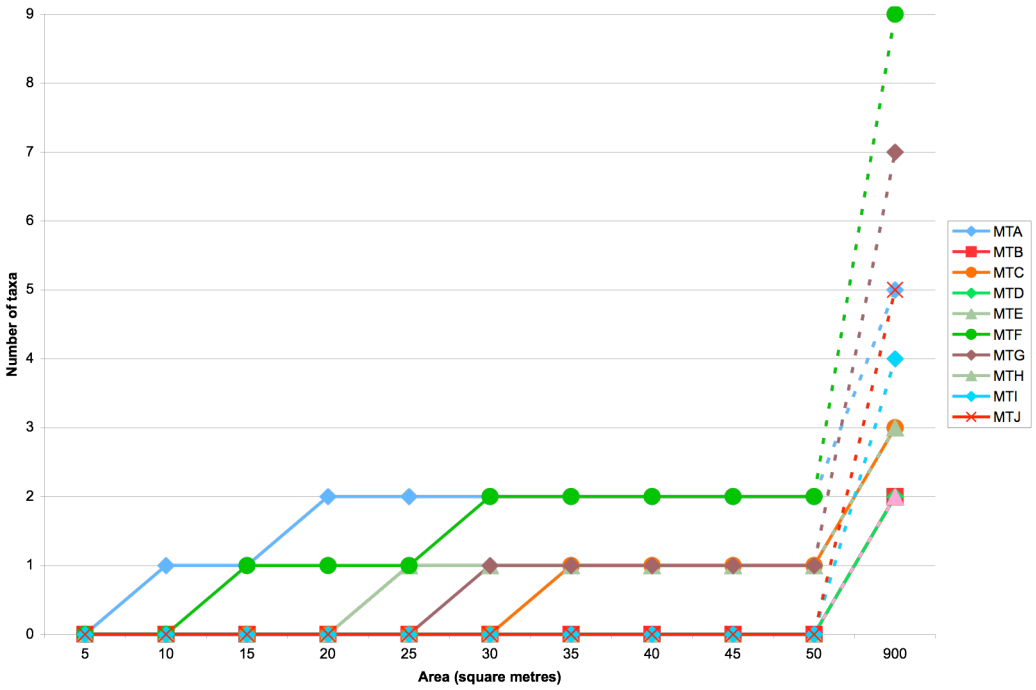


Figure 12. Cumulative numbers of macrofungi by area from alpine heath sites (site names Chapter 2, Table 1) including all surveys. Sites MTB, MTH and MTI overlap.

Repeated macrofungal surveys

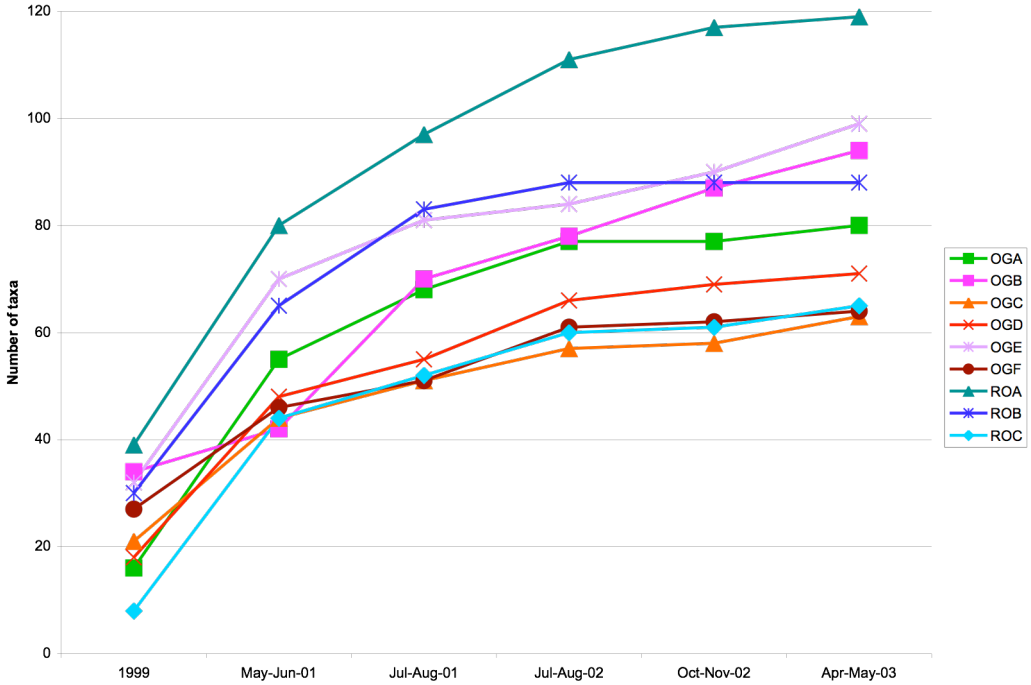


Figure 13. Number of macrofungal taxa observed for successive intensive surveys for wet forest sites (site names Chapter 2, Table 1). Data for survey period includes intervening short survey observations.

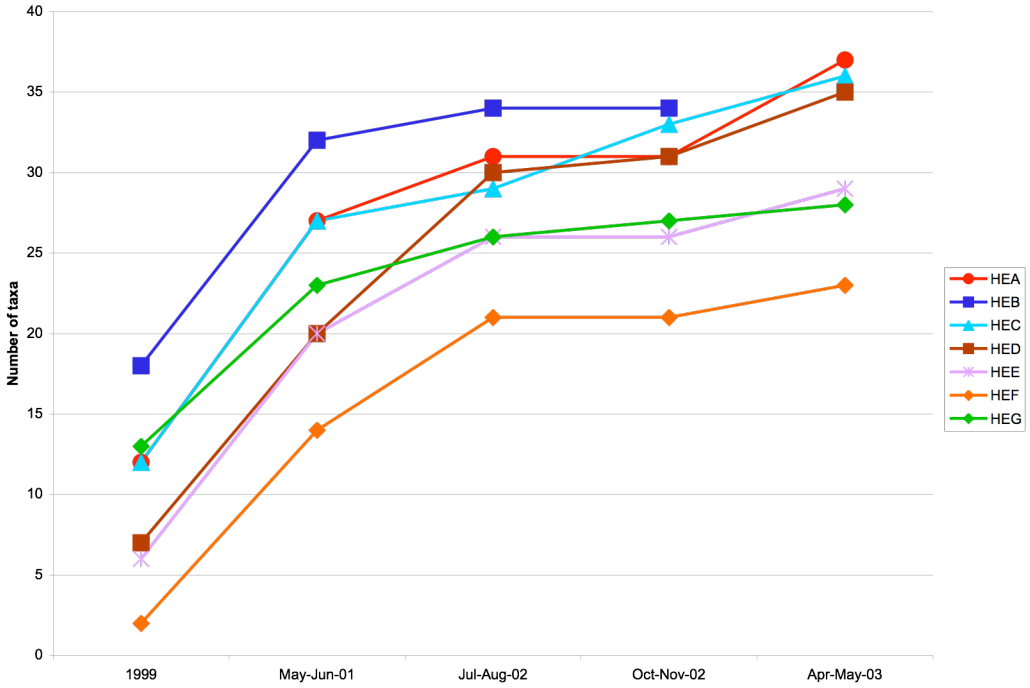


Figure 14. Number of macrofungal taxa observed for successive intensive surveys for heathy woodland sites (site names Chapter 2, Table 1). Data for survey period includes intervening short survey observations. Final survey results for HEB are missing.

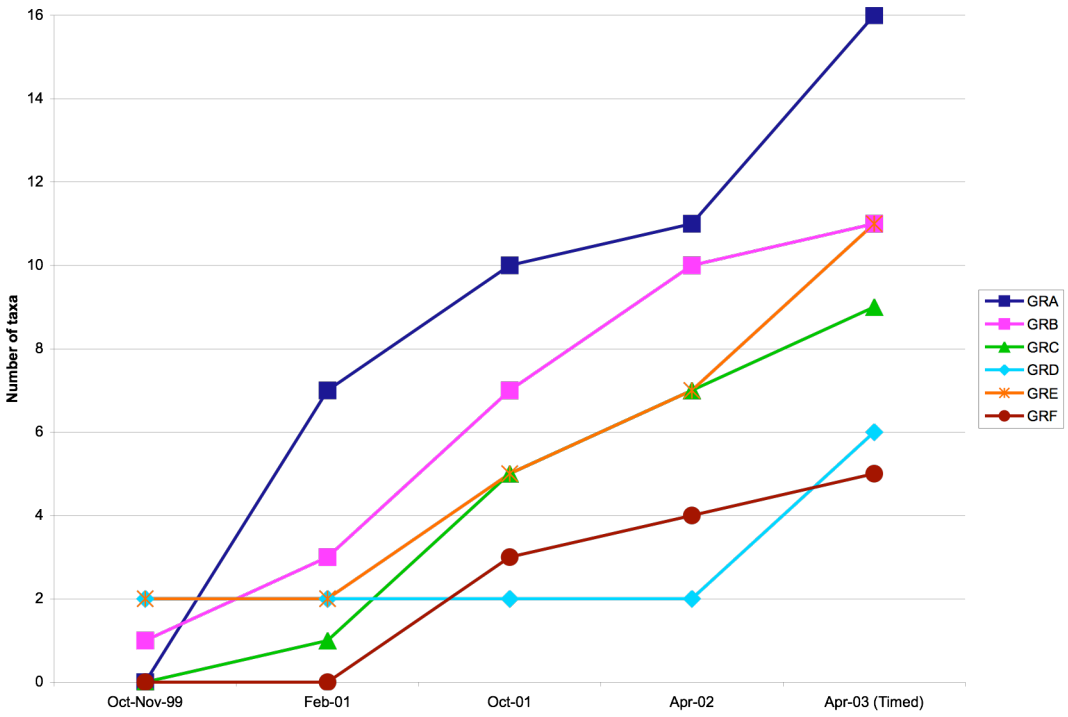


Figure 15. Number of macrofungal taxa observed for successive intensive surveys for grassy woodland sites (site names Chapter 2, Table 1). Data for survey period includes intervening short survey observations. Last survey period used timed mycological survey of sites.

Appendix 7. Vegetation type characterisation and dominants for vascular plants, mosses and macrofungi.

Distribution of taxa across vegetation types of vascular plants (Table 1), mosses (Table 2) and macrofungi (Table 3).

Table 1. Vegetation type characterisation and dominants for vascular plants. Total number of sites in parentheses.

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Acacia dealbata	6	3	3	-
Eucalyptus globulus	6	2	2	-
Exocarpos cupressiformis	4	2	3	-
Eucalyptus viminalis	3	3	5	-
Danthonia spp.	2	2	6	-
Ehrharta stipoides	2	2	4	-
Epacris impressa	1	7	3	-
Leptospermum scoparium	1	6	3	-
Lomandra longifolia	1	4	4	-
Bursaria spinosa	1	2	5	-
Wahlenbergia spp.	1	2	3	-
Pultenaea juniperina	1	1	2	-
Poa spp.	2	1	-	6
Eucalyptus obliqua	9	1	-	-
Pteridium esculentum	8	6	-	-
Acianthus spp.	2	1	-	-
Orchidaceae spp.	2	1	-	-
Pterostylis longifolia	2	1	-	-
Eucalyptus tenuiramis	1	1	-	-
Leptomeria drupacea	1	1	-	-
Bedfordia salicina	8	-	2	-
Acacia verniciflua	6	-	1	-
Rosa rubiginosa	1	-	4	-
Lepidosperma laterale	1	-	2	-
Trifolium spp.	1	-	2	-
Holcus lanatus	1	-	2	-
Taraxacum officinale	1	-	1	-
Vicia spp.	1	-	1	-
Rubus fruticosus	3	-	3	-
Dactylis glomerata	2	-	3	-
Pultenaea daphnoides	2	-	1	-
Billardiera longiflora	4	-	-	1

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Deyeuxia spp.	4	-	-	1
Luzula spp.	2	-	-	8
Carex appressa	1	-	-	1
Epilobium spp.	1	-	-	1
Olearia argophylla	8	-	-	-
Coprosma quadrifida	8	-	-	-
Pittosporum bicolor	7	-	-	-
Pomaderris apetala	7	-	-	-
Dianella tasmanica	5	-	-	-
Zieria arborescens	5	-	-	-
Geranium potentilloides	5	-	-	-
Polystichum proliferum	5	-	-	-
Drymophila cyanocarpa	4	-	-	-
Gahnia grandis	4	-	-	-
Coprosma hirtella	4	-	-	-
Goodenia ovata	4	-	-	-
Chiloglottis spp.	4	-	-	-
Clematis aristata	4	-	-	-
Asterotrichion discolor	3	-	-	-
Beyeria viscosa	3	-	-	-
Acaena novae-zelandiae	3	-	-	-
Senecio linearifolius	3	-	-	-
Eucalyptus regnans	2	-	-	-
Notelaea ligustrina	2	-	-	-
Olearia viscosa	2	-	-	-
Pimelea drupacea	2	-	-	-
Hydrocotyle spp.	2	-	-	-
Lagenifera stipitata	2	-	-	-
Monotoca glauca	1	-	-	-
Nematolepis squamea	1	-	-	-
Gahnia spp.	1	-	-	-
Juncus spp.	1	-	-	-
Cassinia aculeata	1	-	-	-
Cotoneaster spp.	1	-	-	-
Crataegus monogyna	1	-	-	-
Olearia stellulata	1	-	-	-
Pterostylis rufa/squamata	1	-	-	-
Galium aparine	1	-	-	-
Galium spp.	1	-	-	-
Derwentia derwentiana	1	-	-	-
Ranunculus spp.	1	-	-	-

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Thismia rodwayi	1	-	-	-
Agrostis capillaris	1	-	-	-
Anthoxanthum odoratum	1	-	-	-
Histiopteris incisa	1	-	-	-
Microsorum pustulatum	1	-	-	-
Hedera helix	1	-	-	-
Dichelachne spp.	-	4	5	1
Helichrysum scorpioides	-	4	2	4
Agrostis spp.	-	3	2	5
Gonocarpus tetragynus	-	7	3	-
Deyeuxia quadriseta	-	5	4	-
Drosera peltata	-	4	1	-
Leucopogon virgatus	-	5	1	-
Dianella revoluta	-	3	3	-
Goodenia lanata	-	3	3	-
Austrostipa spp.	-	2	6	-
Pimelea humilis	-	2	4	-
Centaurium erythraea	-	2	3	-
Opercularia varia	-	2	2	-
Themeda triandra	-	1	6	-
Carex breviculmis	-	1	5	-
Bossiaea prostrata	-	1	5	-
Acaena echinata	-	1	5	-
Plantago varia	-	1	5	-
Arthropodium milleflorum	-	1	4	-
Lepidosperma gunnii	-	1	4	-
Oxalis perennans	-	1	4	-
Eucalyptus ovata	-	1	3	-
Eucalyptus pulchella	-	1	3	-
Diplarrena moraea	-	1	3	-
Schoenus apogon	-	1	3	-
Astroloma humifusum	-	1	3	-
Lissanthe strigosa	-	1	3	-
Hibbertia hirsuta	-	1	3	-
Hypericum gramineum	-	1	3	-
Leptorhynchos linearis	-	1	3	-
Pentapogon quadrifidus	-	1	3	-
Exocarpos strictus	-	1	2	-
Olearia ericoides	-	1	2	-
Chrysocephalum apiculatum	-	1	2	-
Leptorhynchos squamatus	-	1	2	-

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Ozothamnus obcordatus	-	2	-	1
Prasophyllum spp.	-	1	-	2
Brachyscome spp.	-	1	-	1
Eucalyptus amygdalina	-	7	-	-
Styphelia adscendens	-	7	-	-
Stylidium graminifolium	-	7	-	-
Amperea xiphoclada	-	6	-	-
Aotus ericoides	-	6	-	-
Pimelea linifolia	-	6	-	-
Persoonia juniperina	-	5	-	-
Hypolaena fastigiata	-	4	-	-
Schoenus lepidosperma	-	4	-	-
Allocasuarina monilifera	-	4	-	-
Bossiaea cinerea	-	4	-	-
Dillwynia glaberrima	-	4	-	-
Gompholobium huegelii	-	4	-	-
Hibbertia acicularis	-	4	-	-
Leucopogon collinus	-	4	-	-
Leucopogon ericoides	-	4	-	-
Baeckea ramosissima	-	4	-	-
Cassytha glabella	-	4	-	-
Cassytha pubescens	-	4	-	-
Allocasuarina littoralis	-	3	-	-
Banksia marginata	-	3	-	-
Gahnia radula	-	3	-	-
Daviesia ulicifolia	-	3	-	-
Ehrharta distichophylla	-	3	-	-
Austrostipa mollis	-	3	-	-
Lepidosperma filiforme	-	2	-	-
Tetratheca labillardierei	-	2	-	-
Hibbertia procumbens	-	2	-	-
Rhytidosporum procumbens	-	2	-	-
Glossodia major	-	2	-	-
Austrodanthonia setacea	-	2	-	-
Poa sieberiana	-	2	-	-
Laxmannia orientalis	-	1	-	-
Leptocarpus tenax	-	1	-	-
Restio monocephalus	-	1	-	-
Thelionema caespitosum	-	1	-	-
Acacia genistifolia	-	1	-	-
Acacia suaveolens	-	1	-	-

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Acacia ulicifolia	-	1	-	-
Boronia parviflora	-	1	-	-
Dillwynia sericea	-	1	-	-
Lomatia tinctoria	-	1	-	-
Ulex europaeus	-	1	-	-
Caladenia spp.	-	1	-	-
Brachyscome aculeata	-	1	-	-
Mitrasacme pilosa	-	1	-	-
Aira caryophyllea	-	1	-	-
Schizaea fistulosa	-	1	-	-
Comesperma volubile	-	1	-	-
Hypochaeris radicata	-	-	6	-
Lachnagrostis aemula	-	-	6	-
Dichelachne crinita	-	-	6	-
Allocasuarina verticillata	-	-	5	-
Plantago lanceolata	-	-	5	-
Senecio quadridentatus	-	-	5	-
Elymus scabrus	-	-	5	-
Poa rodwayi	-	-	5	-
Olearia ramulosa	-	-	4	-
Geranium spp.	-	-	4	-
Linum marginale	-	-	4	-
Sanguisorba minor	-	-	4	-
Sonchus spp.	-	-	4	-
Acacia melanoxylon	-	-	3	-
Romulea rosea var. australis	-	-	3	-
Pelargonium inodorum	-	-	3	-
Ranunculus lappaceus	-	-	3	-
Senecio hispidulus	-	-	3	-
Urospermum dalechampii	-	-	3	-
Acacia mearnsii	-	-	2	-
Dodonaea viscosa	-	-	2	-
Dianella brevicaulis	-	-	2	-
Lepidosperma inops	-	-	2	-
Acacia myrtifolia	-	-	2	-
Chrysanthemoides monilifera	-	-	2	-
Dillwynia cinerascens	-	-	2	-
Argentipallium dealbatum	-	-	2	-
Linum trigynum	-	-	2	-
Petrorhagia prolifera	-	-	2	-
Picris spp.	-	-	2	-

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Senecio spp.	-	-	2	-
Veronica gracilis	-	-	2	-
Bulbine glauca	-	-	1	-
Wurmbea dioica	-	-	1	-
Acacia verticillata	-	-	1	-
Boronia nana	-	-	1	-
Melaleuca styphelioides	-	-	1	-
Tetratheca pilosa	-	-	1	-
Pultenaea pedunculata	-	-	1	-
Thelymitra spp.	-	-	1	-
Anagallis arvensis	-	-	1	-
Cirsium arvense	-	-	1	-
Cirsium vulgare	-	-	1	-
Dichondra repens	-	-	1	-
Erigeron karvinskianus	-	-	1	-
Euchiton spp.	-	-	1	-
Hydrocotyle laxiflora	-	-	1	-
Leontodon taraxacoides	-	-	1	-
Raphanus raphinastrum	-	-	1	-
Tragopogon porrifolius	-	-	1	-
Viola hederacea	-	-	1	-
Aira spp.	-	-	1	-
Festuca plebeia	-	-	1	-
Lolium spp.	-	-	1	-
Poa pratensis	-	-	1	-
Bellendena montana	-	-	-	10
Epacris serpyllifolia	-	-	-	10
Orites acicularis	-	-	-	10
Celmisia asteliifolia	-	-	-	10
Carpha alpina	-	-	-	9
Ozothamnus hookeri	-	-	-	9
Ozothamnus rodwayi	-	-	-	8
Orites revoluta	-	-	-	8
Richea scoparia	-	-	-	8
Cyathodes dealbata	-	-	-	8
Pentachondra pumila	-	-	-	8
Lycopodium fastigiatum	-	-	-	8
Olearia algida	-	-	-	7
Olearia ledifolia	-	-	-	7
Richea sprengelioides	-	-	-	7
Schizacme montana	-	-	-	7

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Empodisma minus	-	-	-	6
Uncinia spp.	-	-	-	6
Coprosma nitida	-	-	-	6
Ozothamnus ledifolius	-	-	-	6
Exocarpos humifusus	-	-	-	6
Monotoca empetrifolia	-	-	-	6
Craspedia alpina	-	-	-	6
Plantago tasmanica	-	-	-	6
Astelia alpina	-	-	-	5
Planocarpa petiolaris	-	-	-	5
Leptospermum rupestre	-	-	-	5
Abrotanella forsteroides	-	-	-	5
Acaena montana	-	-	-	5
Euphrasia gibbsiae	-	-	-	5
Oreobolus pumilio	-	-	-	4
Schoenus calyptratus	-	-	-	4
Euphrasia collina	-	-	-	4
Euphrasia striata	-	-	-	4
Gentianella diemensis	-	-	-	4
Poa gunnii	-	-	-	4
Baeckea gunniana	-	-	-	3
Sprengelia incarnata	-	-	-	3
Drosera arcturi	-	-	-	3
Gnaphalium traversii	-	-	-	3
Rubus gunnianus	-	-	-	3
Rytidosperma pauciflorum	-	-	-	3
Hierochloe fraseri	-	-	-	3
Hierochloe redolens	-	-	-	3
Lycopodium scariosum	-	-	-	3
Isolepis crassiuscula	-	-	-	2
Uncinia compacta	-	-	-	2
Tasmannia lanceolata	-	-	-	2
Erigeron pappocromus	-	-	-	2
Erigeron tasmanicus	-	-	-	2
Ourisia integrifolia	-	-	-	2
Senecio pectinatus	-	-	-	2
Carex gaudichaudiana	-	-	-	1
Leucopogon montanus	-	-	-	1
Acrothamnus montanus	-	-	-	1
Olearia pinifolia	-	-	-	1
Asperula gunnii	-	-	-	1

Table 1. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Brachyscome spathulata	-	-	-	1
Celmisia saxifraga	-	-	-	1
Gonocarpus montanus	-	-	-	1
Wahlenbergia saxicola	-	-	-	1
Deyeuxia monticola	-	-	-	1
Huperzia spp.	-	-	-	1

Table 2. Vegetation type characterisation and dominants for mosses. Total number of sites in parentheses.

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Rosulabryum aff. *campylothecium*	2	4	3	2
Ceratodon purpureus	2	4	6	2
Bryum spp.	2	4	6	8
Polytrichum juniperinum	2	2	1	10
Campylopus spp.	3	7	6	10
Fissidens tenellus	7	1	6	-
Rosulabryum billardierei	5	3	3	-
Fissidens taylorii	5	1	6	-
Weissia controversa	2	1	6	-
Breutelia affinis	2	1	2	-
Didymodon australasiae	1	1	-	-
Fissidens curvatus var. *curvatus*	8	-	2	-
Racopilum cuspidigerum var. *convolutaceum*	7	-	1	-
Fissidens leptocladus	5	-	3	-
Fissidens curvatus var. *inclinabilis*	4	-	1	-
Hypnum cupressiforme	9	-	-	5
Ditrichaceae spp.	6	-	-	9
Dicranoloma robustum	5	-	-	6
Hypopterygium didictyon	5	-	-	1
Ptychomnion aciculare	9	-	-	2
Sematophyllaceae spp.	9	-	-	1
Wijkia extenuata	9	-	-	1
Leptotheca gaudichaudii	3	-	-	2
Orthotrichum tasmanicum	2	-	-	1
Brachythecium rutabulum/salebrosum	8	-	-	-
Thuidium sparsum	8	-	-	-
Dicranoloma billardierei	7	-	-	-

Table 2. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Acrocladium chlamydophyllum	9	-	-	-
Lembophyllum clandestinum	5	-	-	-
Rhizogonium novaehollandiae	5	-	-	-
Orthodontium lineare	5	-	-	-
Lembophyllum divulsum	3	-	-	-
Rhizogonium distichum	3	-	-	-
Camptochaete arbuscula	2	-	-	-
Camptochaete deflexa	2	-	-	-
Thamnobryum pumilum	2	-	-	-
Rhynchostegiella muriculata	2	-	-	-
Hypnodendron spp.	1	-	-	-
Hypopterygium spp.	1	-	-	-
Kindbergia praelonga	1	-	-	-
Calyptrochaeta apiculata	1	-	-	-
Calyptrochaeta otwayensis	1	-	-	-
Isopterygium aff. *minutirameum*	1	-	-	-
Calyptopogon mnioides	1	-	-	-
Dicranoloma menziesii	1	-	-	-
Grimmia pulvinata	1	-	-	-
Leucobryum candidum	1	-	-	-
Tortula rubra	-	3	3	-
Bartramia ithyphylla	-	1	-	4
Pseudoleskea imbricata	-	1	-	-
Barbula calycina	-	1	-	-
Pottiaceae spp.	-	-	6	-
Bryum argenteum	-	-	4	-
Philonotis sp. A	-	-	3	-
Philonotis australiensis	-	-	2	-
Bryoerythrophyllum binnsii	-	-	2	-
Pottiaceae sp. A	-	-	2	-
Tortula muralis	-	-	2	-
Acaulon sp.	-	-	1	-
Barbula torquata	-	-	1	-
Tortella calycina/truncata	-	-	1	-
Racomitrium	-	-	-	10
Andreaea spp.	-	-	-	10
Conostomum pusillum	-	-	-	5
Grimmia spp.	-	-	-	5
Racocarpus	-	-	-	4
Breutelia pendula	-	-	-	3

Table 2. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Polytrichum commune	-	-	-	3
Sphagnum spp.	-	-	-	3
Blindia robusta	-	-	-	2
Notoligotrichum aff. *australe*	-	-	-	1

Table 3. Vegetation type characterisation and dominants for macrofungi. Total number of sites in parentheses.

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Heterotextus peziziformis	8	5	1	7
Marasmius spp. II	8	3	1	7
Mycena spp. III	9	3	1	-
Calocera spp.	8	4	2	-
Stereum illudens	8	3	4	-
Cortinarius spp. IV	8	7	2	-
Mycena kuurkea	8	7	1	-
Byssomerulius corium	6	1	1	-
Agaric spp. I	4	4	1	-
Fuligo septica	4	1	1	-
Trametes versicolor	4	1	1	-
Stereum hirsutum	2	2	5	-
Stereales spp.	2	1	2	-
Rhodocollybia butyracea	9	1	-	1
Laccaria sp. B	9	7	-	-
Cortinarius fibrillosus	9	6	-	-
Cortinarius spp. I	8	6	-	-
Lepiota spp. I	8	5	-	-
Entoloma spp. I	6	6	-	-
Lactarius eucalypti	6	3	-	-
Hydnum repandum	6	2	-	-
Discinella terrestris	6	2	-	-
Mycena banksiae complex	8	3	-	-
Discomycete spp. II	9	2	-	-
Dermocybe clelandii complex	8	2	-	-
Mycena austrofilopes	8	2	-	-
Punctularia strigosozonata	8	2	-	-
Dermocybe sp. A	7	2	-	-
Tubaria spp.	5	3	-	-
Polypore spp.	5	2	-	-
Discomycete spp. III	4	3	-	-

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Mycena viscidocruenta	4	2	-	-
Galerina spp. I	3	4	-	-
Boletellus obscurecoccineus	2	3	-	-
Mycena sp. C	1	4	-	-
Pholiota sp. B	1	4	-	-
Hygrocybe graminicolor	1	3	-	-
Mycena aff. *tallangattensis*	1	3	-	-
Entoloma viridomarginatum	1	2	-	-
Mycena interrupta	9	1	-	-
Mycena spp. II	9	1	-	-
Antrodiella citrea	8	1	-	-
Mycena aff. *neerimensis*	7	1	-	-
Clavaria amoena complex	6	1	-	-
Dermocybe austroveneta	6	1	-	-
Inocybe australiensis	6	1	-	-
Cortinarius spp. II	5	1	-	-
Hygrocybe rodwayi	5	1	-	-
Lepiota aff. *haemorrhagica*	5	1	-	-
Marasmius elegans	5	1	-	-
Mycena cystidiosa	5	1	-	-
Clavaria miniata complex	4	1	-	-
Tricholoma spp. I	4	1	-	-
Mycena vinacea complex	4	1	-	-
Fistulinella aff. *prunicolor*	2	1	-	-
Russula clelandii complex	2	1	-	-
Marasmius spp. I	2	1	-	-
Descolea recedens	1	1	-	-
Cystolepiota sp. A	1	1	-	-
Pholiota sp. A	1	1	-	-
Psilocybe subaeruginosa	1	1	-	-
Tremella fuciformis	6	-	1	-
Amanita xanthocephala	3	-	2	-
Panellus stipticus	3	-	1	-
Austropaxillus muelleri complex	2	-	1	-
Tremella mesenterica complex	2	-	1	-
Podoserpula pusio	2	-	1	-
Psathyrella spp.	2	-	1	-
Gymnopilus junonius	1	-	1	-
Mycena epipterygia complex	7	-	-	1
Artomyces spp.	9	-	-	-

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Mycena subgalericulata complex	9	-	-	-
Collybia aff. *eucalyptorum*	8	-	-	-
Galerina muscolignosa complex	8	-	-	-
Mycena sp. A	8	-	-	-
Pholiota multicingulata	8	-	-	-
Torrendiella clealandii	8	-	-	-
Cortinarius abnormis	7	-	-	-
Corticiaceae spp.	7	-	-	-
Mycena austrororida	7	-	-	-
Mycena nargan	7	-	-	-
Marasmiellus affixus	6	-	-	-
Conocybe spp.	6	-	-	-
Crepidotus eucalyptorum	6	-	-	-
Discomycete spp. I	6	-	-	-
Gymnopilus eucalyptorum complex	6	-	-	-
Leotia lubrica	6	-	-	-
Xerula australis	6	-	-	-
Cortinarius spp. III	5	-	-	-
Coprinus aff. *disseminatus*	5	-	-	-
Discomycete sp. D	5	-	-	-
Discomycete spp. IV	5	-	-	-
Galerina patagonica	5	-	-	-
Gloiocephala sp. A	5	-	-	-
Lentinellus hepatotrichus complex	5	-	-	-
Macrotyphula aff. *juncea*	5	-	-	-
Polypore sp. A	5	-	-	-
Rhodocollybia sp. A	5	-	-	-
Clavulina tasmanica	4	-	-	-
Cortinarius archeri	4	-	-	-
Laccaria lateritia	4	-	-	-
Porpoloma sp. A	4	-	-	-
Agaricus sp. A	4	-	-	-
Callistosporium sp. A	4	-	-	-
Geastrum triplex complex	4	-	-	-
Hygrocybe sp. B	4	-	-	-
Hypholoma fasciculare	4	-	-	-
Plectania campylospora	4	-	-	-

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Psathyrella echinata	4	-	-	-
Resupinatus subapplicatus	4	-	-	-
Cortinarius aff. *alboviolaceus*	3	-	-	-
Fistulinella mollis	3	-	-	-
Ramariopsis spp. I	3	-	-	-
Russula neerimea	3	-	-	-
Agaricus sp. B	3	-	-	-
Anthracophyllum archeri	3	-	-	-
Gymnopilus allantopus	3	-	-	-
Lachnum lachnoderma	3	-	-	-
Lycoperdon aff. *pyriforme*	3	-	-	-
Mycena kurramulla	3	-	-	-
Phellinus wahlbergii	3	-	-	-
Pseudobaespora spp.	3	-	-	-
Steccherinum spp.	3	-	-	-
Clavaria spp. I	2	-	-	-
Clavulina redoleo-alii	2	-	-	-
Clavulina sp. B	2	-	-	-
Cortinarius rotundisporus	2	-	-	-
Cortinarius sp. C	2	-	-	-
Geoglossum aff. *glutinosum*	2	-	-	-
Peziza sp. A	2	-	-	-
Ramaria lorithamnus	2	-	-	-
Ramariopsis bicolor	2	-	-	-
Russula aff. *cyanoxantha*	2	-	-	-
Russula purpureoflava	2	-	-	-
Calyptella sp. A	2	-	-	-
Campanella sp. A	2	-	-	-
Collybia spp. I	2	-	-	-
Coprinus sp. A	2	-	-	-
Crepidotus aff. *nephrodes*	2	-	-	-
Discomycete sp. B	2	-	-	-
Discomycete sp. C	2	-	-	-
Galerina aff. patagonica	2	-	-	-
Gymnopilus ferruginosus	2	-	-	-
Hygrocybe aff. *minutula*	2	-	-	-
Hygrocybe astatogala	2	-	-	-
Hygrotrama sp. A	2	-	-	-
Marasmius sp. A	2	-	-	-
Melanotus hepatochrous	2	-	-	-

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Mycena mulawaestris	2	-	-	-
Mycena sp. E	2	-	-	-
Mycena spp. I	2	-	-	-
Pluteus atromarginatus	2	-	-	-
Pluteus sp. A	2	-	-	-
Rhodocybe spp. II	2	-	-	-
Simocybe phlebophora	2	-	-	-
Xylaria aff. *hypoxylon*	2	-	-	-
Amanita aff. *murinaster*	1	-	-	-
Aphelaria sp. A	1	-	-	-
Boletellus ananiceps	1	-	-	-
Clavariaceae sp. A	1	-	-	-
Clavulina sp. A	1	-	-	-
Clavulina vinaceocervina	1	-	-	-
Cortinarius aff. *austroviolaceus*	1	-	-	-
Cortinarius sp. B	1	-	-	-
Cortinarius sp. D	1	-	-	-
Descolea sp. A	1	-	-	-
Lactarius aff. *sepiaceus*	1	-	-	-
Peziza sp. B	1	-	-	-
Ramariopsis corniculata complex	1	-	-	-
Ramariopsis pulchella	1	-	-	-
Russula erumpens	1	-	-	-
Tricholomataceae sp. B	1	-	-	-
Armillaria novaezelandiae	1	-	-	-
Agaric sp. A	1	-	-	-
Agaricus spp. I	1	-	-	-
Ascocoryne sarcoides	1	-	-	-
Bolbitius sp. A	1	-	-	-
Chlorociboria aeruginascens complex	1	-	-	-
Clitocybe sp. A	1	-	-	-
Collybia sp. A	1	-	-	-
Discomycete sp. E	1	-	-	-
Discomycete sp. F	1	-	-	-
Entoloma panniculum	1	-	-	-
Entoloma sp. B	1	-	-	-
Exidia sp. A	1	-	-	-
Gymnopilus moabus	1	-	-	-
Gymnopus alkalivirens	1	-	-	-

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Hohenbuehelia aff. *clelandii*	1	-	-	-
Hohenbuehelia bingarra	1	-	-	-
Hygrocybe sp. A	1	-	-	-
Hygrophorus involutus	1	-	-	-
Mollissia aff. *cinerea*	1	-	-	-
Mycena albidofusca	1	-	-	-
Mycena sp. D	1	-	-	-
Myxomycidium pendulum	1	-	-	-
Pholiota highlandensis	1	-	-	-
Pleuroflammula aff. *flammea*	1	-	-	-
Rickenella fibula	1	-	-	-
Ripartites sp. A	1	-	-	-
Stropharia sp. A	1	-	-	-
Torrediella eucalypti	1	-	-	-
Trogia sp. A	1	-	-	-
Xylaria sp. A	1	-	-	-
Lepiota aff. *fuliginosa*	-	7	-	-
Bovista sp. A	-	5	1	-
Pycnoporus cinnabarinus	-	1	4	-
Strophariaceae spp.	-	2	-	2
Omphalina chromacea	-	5	-	-
Coltricia cinnamomea	-	4	-	-
Rhodocybe spp. I	-	4	-	-
Omphalina umbellifera	-	3	-	-
Austroboletus aff. *occidentalis*	-	3	-	-
Nidula niveo-tomentsa	-	3	-	-
Pisolithus aff. *arhizus*	-	2	-	-
Pulvinula miltina	-	2	-	-
Stropharia semiglobata	-	2	-	-
Amanita griselloides complex	-	1	-	-
Cortinarius aff. *violaceus*	-	1	-	-
Cortinarius sp. E	-	1	-	-
Hebeloma sp. A	-	1	-	-
Inocybe dewrangia complex	-	1	-	-
Agaricus sp. C	-	1	-	-
Hydnellum sp. A	-	1	-	-
Tremella sp. A	-	-	4	-
Aphelaria sp. B	-	-	1	-
Crinipellis sp. A	-	-	1	-
Omphalina sp. A	-	-	-	3

Table 3. Continued

Taxa	WF(9)	HE(7)	GR(6)	MT(10)
Omphalina sp. B	-	-	-	2
Aleuria rhenana	-	-	-	1
Cystoderma muscicola	-	-	-	1
Discomycete sp. A	-	-	-	9
Hygrocybe chlorophana	-	-	-	1
Psilocybe aff. *musci*	-	-	-	1

Appendix 8. Chi-square Goodness-of-Fit tests of substrate frequency for mosses and macrofungi.

Results from Chi-square Goodness-of-Fit tests for substrate frequency of mosses (Table 1) and macrofungi (Table 2).

Table 1. Chi-Square Goodness-of-Fit Test for observed counts of moss across substrates: soil, rock, total litter, and wood. N = number of observations, DF = degrees of freedom.

Mosses	N	DF	Chi^2	P-Value
Acrocladium chlamydophyllum	166	3	36	0.001
Breutelia affinis	21	3	47	0.001
Ceratodon purpureus	49	3	88	0.001
Fissidens curvatus var. *curvatus*	58	3	55	0.001
Fissidens leptocladus	34	3	31	0.001
Fissidens taylorii	31	3	70	0.001
Fissidens tenellus	97	3	118	0.001
Hypnum cupressiforme	40	3	74	0.001
Lembophyllum clandestinum	24	3	17	0.001
Polytrichum juniperinum	58	3	109	0.001
Ptychomnion aciculare	148	3	21	0.001
Racopilum cuspidigerum var. *convolutaceum*	117	3	9	0.034
Rosulabryum billardierei	41	3	38	0.001
Thuidium sparsum	192	3	27	0.001
Tortula rubra	35	3	86	0.001
Weissia controversa	57	3	131	0.001
Wijkia extenuata	150	3	147	0.001

Table 2. Chi-Square Goodness-of-Fit Test for observed counts of macrofungi across substrates: soil, total litter, small wood and large wood. N = number of observations, DF = degrees of freedom.

Macrofungi	N	DF	Chi^2	P-Value
Agaricus sp. A	101	3	282	0.001
Antrodiella citrea	68	3	48	0.001
Byssomerulius corium	31	3	26	0.001
Campanella olivaceonigra	68	3	48	0.001
Cortinarius fibrillosus	68	3	48	0.001
Crepidotus eucalyptorum	36	3	42	0.001
Dermocybe sp. A	29	3	81	0.001
Discinella terrestris	61	3	154	0.001
Discomycete sp. A	34	3	95	0.001
Heterotextus peziziformis	166	3	198	0.001
Hydnum repandum	67	3	185	0.001
Laccaria lateritia	36	3	92	0.001
Lactarius eucalypti	50	3	138	0.001
Laccaria sp. B	113	3	315	0.001
Lepiota aff. fuliginosa	50	3	139	0.001
Macrotyphula aff. juncea	35	3	53	0.001
Marasmiellus affixus	49	3	80	0.001
Marasmius elegans	27	3	38	0.001
Marasmius sp. A	33	3	81	0.001
Mycena aff. neerimensis	48	3	119	0.001
Mycena aff. tallangattensis	56	3	156	0.001
Mycena austrofilopes	102	3	216	0.001
Mycena austroroida	38	3	38	0.001
Mycena cystidiosa	71	3	161	0.001
Mycena interrupta	56	3	75	0.001
Mycena kuurkacea	107	3	257	0.001
Mycena sp. A	101	3	282	0.001
Mycena viscidocruenta	39	3	97	0.001
Omphalina chromacea	84	3	205	0.001
Panellus stipticus	36	3	80	0.001
Peziza echinospora	36	3	69	0.001
Punctularia strigosozonata	77	3	175	0.001
Rhodocollybia butyracea	50	3	118	0.001
Stereum hirsutum	50	3	64	0.001
Stereum illudens	188	3	202	0.001
Torrendiella clelandii	32	3	38	0.001
Trametes versicolor	30	3	54	0.001
Tremella fuciformis	35	3	65	0.001
Xerula australis	50	3	139	0.001

Appendix 9. Moss frequency on substrates across vegetation types.

Vegetation types: WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath. Substrate classes: g = soil, L = litter, W = wood, bW = burnt wood, sbk = smooth bark and rbk = rough bark.

	WF g	HE g	GR g	MT g	WF R	HE R	GR R	MT R	WF L	HE L	GR L	MT L	WF W	HE W	GR W	MT W	WF bW	HE bW	GR bW	MT bW	WF sbk	HE sbk	GR sbk	MT sbk	WF rbk	HE rbk	GR rbk	MT rbk
Weissia controversa	11	4	37	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fissidens taylorii	7	2	19	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortula rubra	-	14	20	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-
Fissidens tenellus	25	3	46	-	21	-	-	-	-	-	-	-	2	-	-	-	3	-	2	-	-	-	-	-	4	-	-	-
Fissidens curvatus var. curvatus	37	-	2	-	17	-	-	-	-	-	-	-	2	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Rosulabryum billardierei	11	9	8	-	10	-	-	-	-	-	-	-	3	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-
Breutelia affinis	1	10	8	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosulabryum aff. campylothecium	2	7	10	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Fissidens leptocladus	17	-	5	-	12	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-
Bartramia ithyphylla	-	5	-	7	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratodon purpureus	1	4	38	1	1	-	-	4	-	-	-	-	-	-	-	-	-	1	5	-	-	-	-	-	-	-	-	-
Polytrichum juniperinum	2	5	1	41	-	-	-	8	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Leptotheca gaudichaudii	1	-	-	5	-	-	-	1	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Dicranoloma robustum	-	-	-	8	-	-	-	1	-	-	-	-	-	-	-	1	6	-	-	-	-	-	-	-	1	-	-	-
Orthotrichum tasmanicum	-	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	5	-	-	-	1	-	-	-
Hypopterygium didictyon	1	-	-	2	3	-	-	-	-	-	-	2	2	-	-	-	2	-	-	-	-	-	-	-	3	-	-	-
Hypnum cupressiforme	6	-	-	6	9	-	-	1	1	-	-	-	16	-	-	1	11	-	-	-	7	-	-	-	11	-	-	-
Wijkia extenuata	33	-	-	1	49	-	-	-	16	-	-	-	51	-	-	-	38	-	-	-	19	-	-	-	22	-	-	-
Ptychomnion aciculare	52	-	-	2	46	-	-	-	27	-	-	-	21	-	-	-	22	-	-	-	12	-	-	-	13	-	-	-

Appendix 10. Macrofungi frequency on substrates across age classes and vegetation types.

Vegetation types: WF = wet forest, HE = heathy woodland, GR = grassy woodland and MT = alpine heath. Study: A = *E. regnans,* B = both studies and C = Hobart area study. Age classes in the E. regnans study are indicated by R and the number of years after fire, e.g. R2 = 2 years after fire. Substrate classes: bg = burnt soil, g = soil, L = litter, W <5 = wood 1-5 cm diam., W >5 = wood greater than 5 cm diam., bW = burnt wood, sbk = smooth bark and rbk = rough bark.

Study	Substrate	R0	R2	R4	R0	R2	R4	R7	R13	R57	WF	HE	GR	MT	R0	R2	R4	R7	R13	R57	WF	HE	GR	MT
		b g	b g	b g	g	g	g	g	g	g	g	g	g	g	L	L	L	L	L	L	L	L	L	L
A	*Laccocephalum mylittae*	8	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Laccocephalum sclerotinum*	24	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Laccocephalum tumulosum*	10	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Neolentinus dactyloides*	21	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Coprinus* sp. A hons	26	1	1	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	Discomycete sp. B hons	14	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Peziza echinospora*	20	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
B	*Discinella terrestris*	8	1	-	1	-	2	1	1	6	39	11	-	-	-	-	-	-	-	-	-	-	-	1
B	*Laccaria lateritia*	3	-	-	-	1	-	1	2	2	23	1	-	-	-	-	-	-	1	-	-	-	-	-
B	*Hydnum repandum*	-	-	-	-	-	-	3	6	7	28	31	-	-	-	-	-	-	-	-	-	-	-	-
B	*Lactarius eucalypti*	-	-	-	-	-	-	-	4	6	37	3	-	-	-	-	-	-	-	-	-	-	-	-
C	*Laccaria* sp. B	*	*	*	*	*	*	*	*	*	49	64	-	-	*	*	*	*	*	*	-	-	-	-
C	*Fistulinella mollis*	*	*	*	*	*	*	*	*	*	16	6	-	-	*	*	*	*	*	*	-	-	-	-
C	*Cortinarius fibrillosus*	*	*	*	*	*	*	*	*	*	47	63	-	-	*	*	*	*	*	*	-	-	-	-
C	*Mycena* aff. *neerimensis*	*	*	*	*	*	*	*	*	*	-	-	-	-	*	*	*	*	*	*	38	8	-	-
B	*Leotia lubrica*	-	-	-	-	-	-	-	-	5	11	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Xerula australis*	-	-	-	-	-	-	-	1	-	47	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Mycena kuurkea*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91	10	-	-
B	*Mycena austrofilopes*	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	1	21	2	68	5	-	-
B	*Mycena cystidiosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	18	10	34	-	-	-
B	*Marasmius elegans*	-	-	-	4	-	-	-	3	1	1	-	-	-	-	-	-	1	-	-	7	-	-	-
A	*Campanella olivaceonigra*	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	4	21	-	*	*	*	*
B	*Heterotextus peziziformis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	10	1	14	1	-	-	-	-
B	*Stereum illudens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-
B	*Byssomerulius corium*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-

Appendix 10. Continued

Study	Substrate	R0 W <5	R2 W <5	R4 W <5	R7 W <5	R13 W <5	R57 W <5	WF W <5	HE W <5	GR W <5	MT W <5	R0 W >5	R2 W >5	R4 W >5	R7 W >5	R13 W >5	R57 W >5	WF W >5	HE W >5	GR W >5	MT W >5
A	*Laccocephalum mylittae*	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Laccocephalum sclerotinum*	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Laccocephalum tumulosum*	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Neolentinus dactyloides*	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Coprinus* sp. A hons	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	Discomycete sp. B hons	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Peziza echinospora*	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
B	*Discinella terrestris*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Laccaria lateritia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Hydnum repandum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Lactarius eucalypti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	*Laccaria* sp. B	*	*	*	*	*	*	-	-	-	-	*	*	*	*	*	*	-	-	-	-
C	*Fistulinella mollis*	*	*	*	*	*	*	-	-	-	-	*	*	*	*	*	*	-	-	-	-
C	*Cortinarius fibrillosus*	*	*	*	*	*	*	1	-	-	-	*	*	*	*	*	*	1	-	-	-
C	*Mycena* aff. *neerimensis*	*	*	*	*	*	*	1	-	-	-	*	*	*	*	*	*	2	-	-	-
B	*Leotia lubrica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
B	*Xerula australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Mycena kuurkea*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	4	-	-	-
B	*Mycena austrofilopes*	1	-	-	-	2	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-
B	*Mycena cystidiosa*	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
B	*Marasmius elegans*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	*Campanella olivaceonigra*	20	-	-	1	6	-	*	*	*	*	-	-	-	-	2	2	*	*	*	*
B	*Heterotextus peziziformis*	-	3	1	-	5	2	49	9	-	52	-	-	3	-	2	6	2	3	-	-
B	*Stereum illudens*	1	3	2	1	8	-	77	6	-	-	-	8	4	-	1	13	20	4	-	-
B	*Byssomerulius corium*	-	-	1	5	2	1	9	1	-	-	-	-	2	1	1	4	2	-	-	-

Appendix 10. Continued

Study	Substrate	R0	R2	R4	R7	WF	HE	GR	MT	WF	HE	GR	MT	WF	HE	GR	MT
		bW	bW	bW	bW	bW	bW	bW	bW	sbk	sbk	sbk	sbk	rbk	rbk	rbk	rbk
A	*Laccocephalum mylittae*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Laccocephalum sclerotinum*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Laccocephalum tumulosum*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Neolentinus dactyloides*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Coprinus* sp. A hons	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	Discomycete sp. B hons	6	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Peziza echinospora*	8	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
B	*Discinella terrestris*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Laccaria lateritia*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Hydnum repandum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Lactarius eucalypti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	*Laccaria* sp. B	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
C	*Fistulinella mollis*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
C	*Cortinarius fibrillosus*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
C	*Mycena* aff. *neerimensis*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
B	*Leotia lubrica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Xerula australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Mycena kuurkea*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
B	*Mycena austrofilopes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Mycena cystidiosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Marasmius elegans*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
A	*Campanella olivaceonigra*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
B	*Heterotextus peziziformis*	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
B	*Stereum illudens*	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Byssomerulius corium*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-

Appendix 10. Continued

Study	Substrate	R0	R2	R4	R0	R2	R4	R7	R13	R57	WF	HE	GR	MT	R0	R2	R4	R7	R13	R57	WF	HE	GR	MT
		b g	b g	b g	g	g	g	g	g	g	g	g	g	g	L	L	L	L	L	L	L	L	L	L
B	*Punctularia strigosozonata*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
B	*Torrendiella clealandii*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-
B	*Marasmiellus affixus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	2	1	-	-	-
B	*Mycena austrororida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	1	-	-	-
B	*Crepidotus eucalyptorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	*Crepidotus variabilus*	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	2	1	-	*	*	*	*
C	*Stereum hirsutum*	*	-	-	*	-	-	-	-	-	-	-	-	-	*	*	*	*	*	*	-	-	-	-
A	*Xylaria apiculata*	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
A	*Dictyopanus pusillus*	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*
B	*Fuligo septica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-
B	*Galerina patagonica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
B	*Gloiocephala* sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-	-	-
B	*Mycena interrupta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
B	*Panellus stipticus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Psathyrella echinata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Trametes versicolor*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Pycnoporus cinnabarinus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	*Schizophyllum commune*	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	-	-	-	*	*	*	*

Appendix 10. Continued

Study	Substrate	R0 W <5	R2 W <5	R4 W <5	R7 W <5	R13 W <5	R57 W <5	WF W <5	HE W <5	GR W <5	MT W <5	R0 W >5	R2 W >5	R4 W >5	R7 W >5	R13 W >5	R57 W >5	WF W >5	HE W >5	GR W >5	MT W >5
B	*Punctularia strigosozonata*	-	-	-	2	8	4	60	2	-	-	-	-	-	-	-	3	2	-	-	-
B	*Torrendiella clealandii*	-	-	-	-	3	2	20	-	-	-	-	-	-	-	2	1	1	-	-	-
B	*Marasmiellus affixus*	-	-	-	-	3	-	37	-	-	-	-	-	-	-	-	2	4	-	-	-
B	*Mycena austrororida*	-	-	-	-	-	-	26	-	-	-	-	-	-	1	-	2	5	-	-	-
B	*Crepidotus eucalyptorum*	-	-	-	1	2	-	16	-	-	-	-	-	-	-	-	4	14	-	-	-
A	*Crepidotus variabilus*	-	-	-	-	4	3	*	*	*	*	-	1	-	-	1	1	*	*	*	*
C	*Stereum hirsutum*	*	*	*	*	*	*	5	6	-	-	*	*	*	*	*	*	2	-	-	-
A	*Xylaria apiculata*	-	-	-	3	1	3	*	*	*	*	-	-	-	1	2	3	*	*	*	*
A	*Dictyopanus pusillus*	-	-	1	-	1	2	*	*	*	*	-	-	-	-	1	7	*	*	*	*
B	*Fuligo septica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
B	*Galerina patagonica*	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1	5	-	-	-
B	*Gloiocephala* sp. A	-	-	-	-	-	-	8	-	-	-	-	-	-	-	2	3	1	-	-	-
B	*Mycena interrupta*	-	-	-	-	-	3	20	-	-	-	-	-	-	2	6	5	24	1	-	-
B	*Panellus stipticus*	-	-	1	-	1	2	5	-	-	-	-	1	3	-	1	-	19	-	-	-
B	*Psathyrella echinata*	-	-	-	-	-	-	1	-	-	-	1	2	2	1	18	5	8	-	-	-
B	*Trametes versicolor*	-	-	-	-	-	-	3	1	-	-	-	4	2	-	2	-	7	-	-	-
B	*Pycnoporus cinnabarinus*	-	-	-	-	-	-	-	1	-	-	-	1	2	-	-	-	-	-	-	-
A	*Schizophyllum commune*	-	-	-	-	-	-	*	*	*	*	-	1	1	-	-	-	*	*	*	*

Appendix 10. Continued

Study	Substrate	R0 bW	R2 bW	R4 bW	R7 bW	WF bW	HE bW	GR bW	MT bW	WF sbk	HE sbk	GR sbk	MT sbk	WF rbk	HE rbk	GR rbk	MT rbk
B	*Punctularia strigosozonata*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
B	*Torrendiella clealandii*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
B	*Marasmiellus affixus*	-	-	-	-	-	-	-	-	5	-	-	-	3	-	-	-
B	*Mycena austrororida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Crepidotus eucalyptorum*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
A	*Crepidotus variabilus*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
C	*Stereum hirsutum*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
A	*Xylaria apiculata*	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
A	*Dictyopanus pusillus*	1	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*
B	*Fuligo septica*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Galerina patagonica*	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	*Gloiocephala* sp. A	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
B	*Mycena interrupta*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
B	*Panellus stipticus*	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
B	*Psathyrella echinata*	-	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
B	*Trametes versicolor*	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
B	*Pycnoporus cinnabarinus*	-	8	4	-	-	-	-	-	-	-	-	-	-	-	-	-
A	*Schizophyllum commune*	20	1	1	-	*	*	*	*	*	*	*	*	*	*	*	*

SOME MACROFUNGI FROM ALPINE TASMANIA

S.J.M. McMullan-Fisher [1], T.W. May [2] & J.B. Kirkpatrick [1]

[1] School of Geography and Environmental Studies, University of Tasmania, Private Bag 78, Hobart, Tasmania 7001, Australia.
[2] Royal Botanic Gardens Melbourne, Private Bag 2000, South Yarra, Victoria 3141, Australia.

Abstract

Macrofungi from the alpine area of Mt Wellington were surveyed fortnightly in 1999 and 2001 on permanent plots of known fire history. Macrofungi were present during half of the surveys. Other incidental surveys were carried out in Tasmanian alpine areas on the Central Plateau and at Mt Field. A total of 22 taxa were recognised. These included *Aleuria rhenana*, *Cystoderma muscicola*, *Heterotextus peziziformis*, *Hygrocybe chlorophana*, *Mycena epipterygia*, *Rhodocollybia butyracea* and species of *Entoloma*, *Gymnopus*, *Mycena*, *Lycoperdon*, *Marasmius*, *Omphalina*, *Panaeolus*, *Psathyrella* and *Psilocybe*. Two mycorrhizal taxa, *Laccaria* sp. B and an unidentified species of *Inocybe*, were found in alpine heath from the Tasmanian Central Plateau. The Tasmanian alpine macrofungi are compared with those present in adjacent non-alpine areas, and to the macrofungi of alpine areas in the northern hemisphere.

S.J.M. McMullan-Fisher *et al.* (2003). Some macrofungi from alpine Tasmania. *Australasian Mycologist* 22 (1): 44–52.

Introduction

Alpine vegetation is that which occurs above the climatic limit for the growth of trees. In Tasmania alpine vegetation occurs in habitat islands, relictual from a much wider distribution in the last glacial period. The boundary of Tasmanian alpine vegetation is rarely abrupt, and treeless areas can occur in the lowlands. The climatic tree line in Tasmania varies from 800 to 1400 m above sea level, depending on latitude and distance inland from the sea (Kirkpatrick 1982, 1997). Tasmania's alpine vegetation is globally unusual in that most of its area is dominated by scleromorphic shrubs and/or hard cushion (bolster) plants, a product of the inconstancy of snow in a maritime environment (Kirkpatrick 1983, 1997).

Three main elements of the vascular plant flora have been described for alpine Tasmania: Cosmopolitan, Australian and Gondwanan (Kirkpatrick & Brown 1984). In contrast, little work has been done on alpine macrofungi in Tasmania, or indeed Australasia. There have been no systematic surveys for Australian alpine macrofungi, with only a few species of alpine Hygrophoraceae and *Galerina* included in recent revisions (Wood 2001, Young & Wood 1997). Globally, there is some similarity between the fungi of alpine areas and those from arctic regions (Laursen 1982). Horak (1982) studied macrofungi from Antarctica and subantarctic islands, including Macquarie Island. He found no evidence of ectomycorrhizal associations, contrasting with the northern polar and subpolar areas where ectomycorrhizal associations are common. For Macquarie Island, Laursen *et al.* (1997) also found no evidence of ectomycorrhizal associations.

In this paper we report both systematic and casual observations of macrofungi in three Tasmanian alpine areas: Mount Wellington, Mount Field and the Central Plateau. The data presented include records from permanent plots of known fire history, part of a larger survey of the macrofungi of Mt Wellington. We compare the suite of Tasmanian alpine macrofungi with the macrofungi of adjacent non-alpine areas and also with data on alpine macrofungi from the northern hemisphere.

Methods

On Mt Wellington, ten 30 × 30 m sites were established in the alpine zone within 1 km of the summit (Australian Map Grid Zone 55G 518000E 5250000N) (Table 1). Five sites were burnt in 1962 (1962 sites), three sites were last burnt in 1947 (1947 sites), and two sites are in areas on the boundary of the 1962 fire where there is a patchy

distribution of areas last burnt in 1947 or 1962. Within each site ten 1 × 5 m parallel strip-plots were randomly located. These strip-plots gave an area of 50 m^2 to be used for intensive and substrate cover surveys.

Intensive surveys of these strip plots were carried out for five of the ten sites on Mt Wellington in April 1999; three sites burnt in 1962, one burnt in 1947 and one on the boundary of the 1962 and 1947 fires. At each site the strip-plots were surveyed for all macrofungal taxa present. For the intensive survey, taxa not seen in strip-plots but seen within the site were also recorded. Any taxa seen incidentally while moving between sites were also recorded. Substrate types were recorded during surveys in 2001–2003 for the strip-plots from all sites using the following cover classes: 1 = 0–1%, 2 = 2–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%. Leaf litter is the leaf litter not including the leaf litter from *Orites acicularis*. *Orites acicularis* litter is the leaf and seed pod litter only from *O. acicularis*. Wood Total is all wood greater than 50 mm in diameter, and is the cumulative total of wood classes.

Table 1. Location and site data. Vegetation types are according to Kirkpatrick (1997).

Location	Elevation (m)	Vegetation	No. Sites	Aspect & Slope (site no. (direction, M.N., slope))	Fire History	Surveys
Mt Wellington	1210–1230	Alpine heath and grassland	3	1(078°, 4°), 2(169°, 2°), 3(179°, 1°)	Last fire 1947	Short (all sites) + Intensive (1 site)
Mt Wellington	1210–1230	Alpine heath and grassland	5	1(114°, 1°), 2(065°, 2°), 3(0, 0°), 4(0, 0°), 5(091°, 1°)	Last fire 1962	Short (all sites) + Intensive (3 sites)
Mt Wellington	1210–1230	Alpine heath and grassland	2	1(031°, 1°), 2(076°, 1°)	Last fire 1947 or 1962	Short (all sites) + Intensive (1 site)
Mt Field, Newdegate Pass	1280	Bolster heath	-		Not known	Incidental only
Central Plateau	900–1150	Alpine heath and grassland	-		Not known	Incidental only

On Mt Wellington all sites were also surveyed by a short survey each month between June–December 1999 and March–October 2001. The short surveys involved searching for macrofungi for ten minutes along a central 30 × 2 m transect. Half the sites were surveyed each fortnight, so each site was visited monthly during survey periods. Complete snow cover prevented surveys about a fifth of the time.

Surveys for macrofungi involved looking at all potential fungi habitat, without damaging the substrates or vegetation as repeated surveys were made. The frequency of macrofungi was observed by considering each new patch of substrate as a single occurrence, rather than by counting individual fruiting bodies (the density and spacing of which can vary for different taxa). Occurrence of a taxon on the same piece of wood or patch of leaf litter was considered as a single observation. So, if a taxon was seen on five separate pieces of substrate on one site it was recorded as having a frequency of five for that site. For a particular survey occasion, frequency was pooled over sites.

Incidental observations, when between sites and visiting sites for other surveys, were recorded for Mt Wellington. Macrofungi were also collected and observed incidentally, during vegetation investigations, in two other alpine areas in Tasmania: Newdegate Pass, Mt Field (AMG Zone 55G 462800E 527740N) and at five localities on the Central Plateau (within the rectangle defined by AMG Zone 55G 473000-483000E 5270000-5360000N) (Table 1). The Mt Field observation period was one survey day in February 1999. The Central Plateau observation period included one day in November 1999 and one day in December 2001. All surveys were carried out by one observer (SJMM).

Fungi fruit bodies for identification were collected. Characteristics were recorded within a day of collection, photographs were taken and if possible, a spore print was made. Specimens were dried using a food dehydrator at 30°C. Identifications were carried out using a light microscope with magnification up to ×1000 and material mounted in a weak KOH solution or Melzer's reagent. Whenever possible, a voucher specimen for each taxon

was lodged at the National Herbarium of Victoria (MEL). For some taxa, material was immature or over-mature or in poor condition and not suitable for vouchering. Names for fungi follow May *et al.* (2003). Mycorrhizal status follows Trappe (1962) and Hobbie *et al.* (2001).

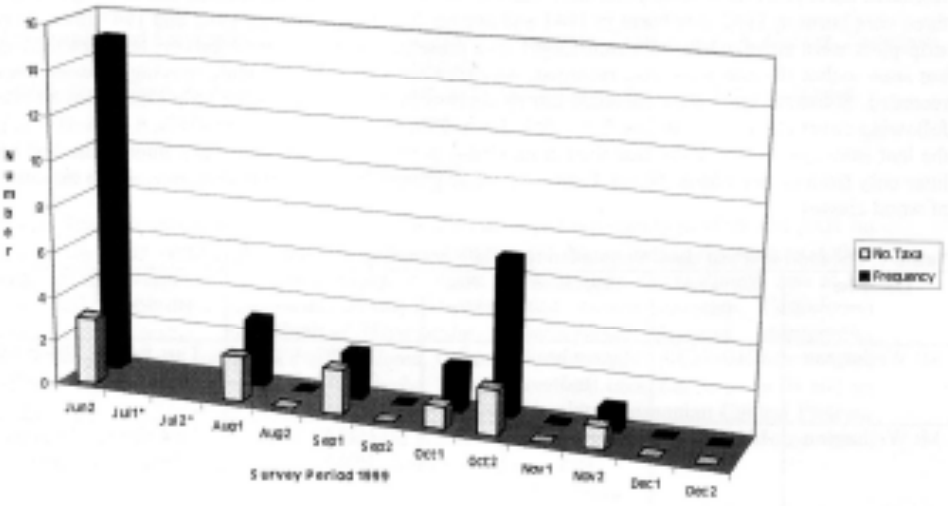


Figure 1. Short surveys of macrofungi on Mt Wellington in 1999, showing total number of taxa, and frequency of observations (* indicates that no survey was completed due to complete snow cover of vegetation).

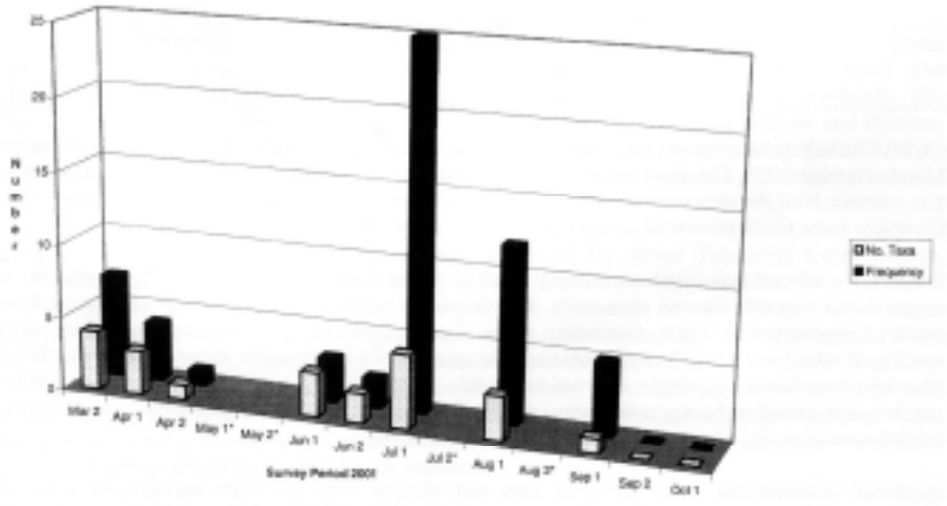


Figure 2. Short surveys of macrofungi on Mt Wellington in 2001, showing total number of taxa, and frequency of observations (* indicates that no survey was completed due to complete snow cover of vegetation).

Results

For the Mt Wellington sites at least one taxon was seen during half of the short surveys (Figs 1 and 2). When fungi were present, there were between one and four taxa, usually at low frequencies. On July 1 2001 the high frequency was due to Discomycete sp. A and *Heterotextus peziziformis*, with frequencies of fourteen and seven respectively. For the intensive survey, a total of nine taxa were seen (Fig. 3). Ten taxa in total were seen during

short surveys. Two taxa (*Entoloma* sp. and *Lycoperdon* sp.) were only seen during incidental surveys, and did not occur on the sites. Across all the sites and surveys, a total of 22 taxa were observed (Table 2). Of these, eight taxa were only seen once, and most other taxa were seen less than ten times. Discomycete sp. A, *H. peziziformis* and *Marasmius* spp. were seen 38, 35 and 13 times respectively. The accumulation of species over visits (Fig. 4) was a reasonably steep curve initially, but with no new taxa recorded after the ninth visit when considering the total for all sites.

Of the 17 taxa collected overall, six were named species, and the *Laccaria* agreed with the description of *Laccaria* sp. B by May (1997). A further six taxa were distinctive enough to be recognised from one visit to the next, although they were not described in the current literature. These six were distinguished as Discomycete sp. A, *Gymnopus* sp. A, and three species of *Omphalina* (spp. A, B and C). The remaining eight macrofungal taxa were identified to family or genus, and in some cases more than one species could have been present, such as in *Marasmius*. The only mycorrhizal taxa collected were *Laccaria* sp. B and *Inocybe* sp.

Comparing the sites on Mt Wellington of known fire history (Table 3), one taxon was found only on 1947 sites, six on both site types, and six only on the 1962 sites. The total number of taxa on the 1962 sites was about twice that of the 1947 sites, although there were fewer 1947 sites. Of the taxa seen on more than four occasions, *Heterotextus peziziformis*, *Marasmius* spp. and Discomycete sp. A were found on both age classes, with the latter on all of the 1947 and three of the five 1962 sites, whilst *Omphalina* sp. A only occurred on 1962 sites (two of five sites). Discomycete sp. A was only found on the leaf litter of *Orites acicularis*. This is one of the plants that differs greatly in cover between the two ages classes (Kirkpatrick *et al.* 2002). The amount of this substrate differed between the two age classes in the present samples (Fig. 5). Total wood also differs between the two age classes.

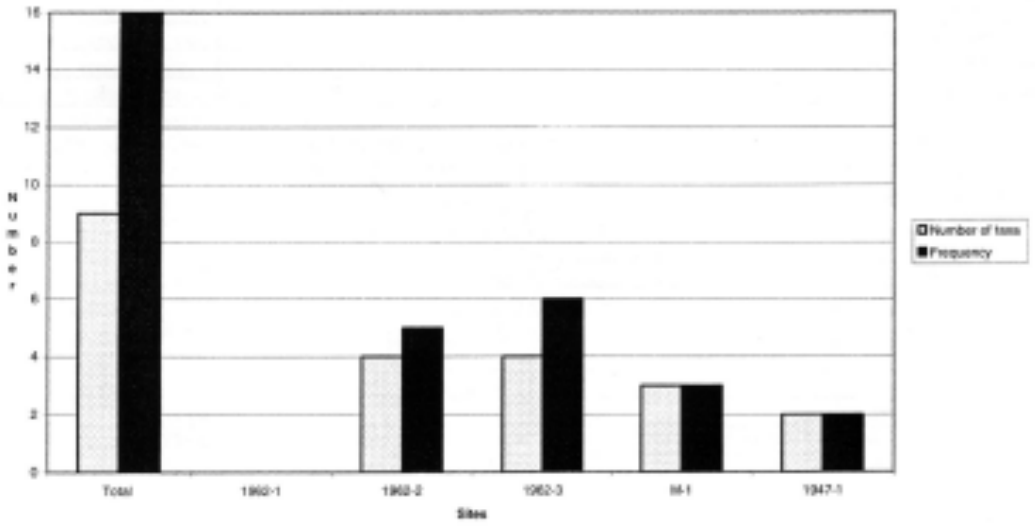


Figure 3. Intensive survey for macrofungi on Mt Wellington in 1999, showing the number of taxa in total and for each site surveyed, and the frequency of macrofungi observations. Sites burnt in 1962 (three sites), M: fire boundary of 1947–1962 site (one site), site burnt in 1947 (one site).

Discussion

The levelling out of the species accumulation curve after one year shows that the survey effort was adequate to gain a preliminary picture of the most common taxa of macrofungi present in the alpine zone of Mt Wellington. The low sample intensity of 22 days over the study period indicates that many taxa are likely to have been overlooked, as species could have been present only as mycelia, or might not have produced fruiting bodies. There will also have been additional diversity present since some of the taxa recorded may well represent more than one species. Despite this, the study established that there is a suite of macrofungi present in alpine habitats in Tasmania.

Table 2. Macrofungi recorded from three alpine areas in Tasmania.

Taxon	Mt Wellington	Central Plateau	Mt Field
Ascomycota			
Aleuria rhenana	+	-	-
Discomycete sp. A	+	-	-
Basidiomycota			
Cystoderma muscicola	+	-	-
Entoloma spp.	+	+	-
Gymnopus sp. A	+	-	-
Heterotextus peziziformis	+	-	-
Hygrocybe chlorophana	+	+	-
Inocybe sp.	-	+	-
Laccaria sp.	-	+	-
Lycoperdon sp.	+	+	-
Marasmius spp.	+	+	-
Mycena epipterygia	+	-	-
Mycena sp.	+	-	-
Omphalina sp. A	+	-	-
Omphalina sp. B	+	-	-
Omphalina sp. C	-	-	+
Panaeolus sp.	-	+	-
Psathyrella sp.	-	+	-
Psilocybe sp.	+	-	-
Rhodocollybia butyracea	+		-
Strophariaceae spp.	+	+	-
Tricholomataceae sp.	+	-	-
Total number of taxa	**17**	**9**	**1**

Table 3. Comparison of macrofungi on sites on Mt Wellington burnt in the 1947 or 1962 fires. Figures are percentage of sites on which taxon present (total number of observations of taxon on sites). Data are pooled across the 22 days of short and intensive surveys.

Taxon	1947	1962
Psilocybe sp.	33 (1)	
Discomycete sp. A	100 (12)	80 (8)
Heterotextus peziziformis	67 (9)	60 (17)
Marasmius spp.	33 (1)	60 (8)
Mycena sp.	33 (1)	20 (1)
Omphalina sp. B	33 (1)	20 (1)
Strophariaceae spp.	33 (1)	20 (1)
Aleuria rhenana		20 (1)
Rhodocollybia butyracea		20 (1)
Cystoderma muscicola		20 (1)
Gymnopus sp. A		20 (1)
Hygrocybe chlorophana		20 (1)
Omphalina sp. A		40 (4)
Number of sites	**3**	**5**
Total number of taxa	**7**	**12**

The rather restricted suite of macrofungi contrasts markedly with the much greater diversity of fruit bodies at generic and species level observed in nearby lower elevation forested areas (McMullan-Fisher unpubl.). Such vegetation is characterised by a diverse mycoflora including numerous species of *Cortinarius*, *Lactarius*, *Russula* and members of the Boletales (among ectomycorrhizal fungi) and *Mycena*, Poriales and Stereales (among saprotrophs). Numerous species in these and other genera that have been recorded from nearby forests on Mt Wellington, Mt Field and on the Central Plateau (McMullan-Fisher unpubl., Ratkowsky & Gates 2002) were not observed on the alpine sites.

The Tasmanian alpine environment is climatically variable, with short periods of snow recorded from all months of the year. This absence of protective snow cover exposes the alpine heath community to the particularly harsh weather conditions common in alpine Tasmania (Kirkpatrick 1982, Kirkpatrick *et al.* 2002), which may limit the fruiting period of macrofungi. We observed that the alpine macrofungi often were morphologically deformed, probably due to these harsh growing conditions. The single taxon from Mt Field, *Omphalina* sp. C, was recorded during days of over 25°C, highlighting that some taxa may appear at any time. Ten of the taxa seen from Mt Wellington were recorded from the fortnightly short surveys. Some of these taxa seem periodically abundant, especially *H. peziziformis*, Discomycete sp. A and *Marasmius* sp. One day of intensive surveying of five of the ten Mt Wellington sites did yield five additional species (*Cystoderma muscicola*, *Gymnopus* sp. A, *Mycena epipterygia*, *Mycena* sp. and *Psilocybe* sp.) bringing the total taxa observed from Mt Wellington to seventeen. The use of frequent short surveys is one means of detecting peak fruiting times; then more intensive surveys can be carried out. Research into the climatic conditions that stimulate fruit body production would also assist in targeting surveys to times of high macrofungal abundance.

The alpine macrofungal mycota found to date is dominated by saprotrophs. It is likely that these fungi have an important role in decomposition in the alpine areas of Tasmania. The Central Plateau surveys gave a total of nine taxa, four of which had not been recorded in other areas, including two ectomycorrhizal taxa; *Laccaria* sp. B and *Inocybe* sp. The difference in sampling effort (three days only as compared with 22 days for Mt Wellington) means that the differences in the diversity are not statistically meaningful, but the distribution of ectomycorrhizal taxa is of interest. *Laccaria* is a distinctive genus in the field and readily confirmed from microscopic characters. While several species of *Laccaria*, including *Laccaria* sp. B, have been observed in forested areas of Mt Wellington, no fruit bodies were seen on the alpine sites on Mt Wellington despite the regular sampling. *Eucalyptus*, a common host of ectomycorrhizal fungi, was absent from all the alpine sites surveyed, but other potential host genera in the Myrtaceae (Brundrett 1999) and Asteraceae were present (Warcup 1990). Further observations are required on the associated plants of alpine ectomycorrhizal fungi. Once potential hosts have been identified, the variation in occurrence of associated fungi could be investigated across sites. *Aleuria* and *Entoloma* species may be ectomycorrhizal (Antibus *et al.* 1981, Hobbie *et* al 2001), and these genera also warrant further investigation as to their possible hosts. Laursen *et al.* (1997) found no evidence of ectomycorrhizal fungi on Macquarie Island, but this is most likely because this is a recently vegetated island, whilst Tasmania has been consistently vegetated throughout the Pleistocene.

The particularly slow growth of Tasmanian alpine vegetation and its relatively poor regenerative capacity (Bridle *et al.* 2001, Kirkpatrick & Dickinson 1984, Kirkpatrick *et al.* 2002), means that, as far as their vascular plant communities, areas burnt in 1947 and 1962 are still easily distinguished more than thirty-years after fire. The cover of substrates relevant to macrofungi (such as litter and wood) is similar for sites of different fire history, with the exception of *Orites acicularis* leaf litter and total wood. However, we have presented no strong evidence for a distinct suite of fungi in each age class. Although the species richness was higher on sites burnt in 1962 (12 taxa compared with seven on 1947 sites), the differences between the two age classes could be explained by the greater number of 1962 burn sites, especially since many of the taxa were observed only once.

Of the macrofungi that could be named in the alpine sites, *H. peziziformis*, *Rhodocollybia butyracea*, *Mycena epipterygia* and *Laccaria* sp. B are common in other vegetation communities in Tasmania and mainland Australia, while *Aleuria rhenana* and *Cystoderma muscicola* are less common but also widely distributed (May unpubl.). Only *Hygrocybe chlorophana* has been previously recorded from alpine Australia. This species is known only from alpine heath in Kosciuzsko National Park (Young & Wood 1997: as *Hygrocybe flavescens*; Young 2000). The only other agarics reported from alpine Australia are two species of *Galerina* (Wood 2001), but no species of this genus were recorded in the present study. *Omphalina* sp. A, distinguished by its short, robust habit and dark brown/grey colour, was always found on cushion plants, which have an alpine distribution. This taxon has not been observed elsewhere, and because of the association with cushion plants, may also be restricted to alpine sites.

The suite of Tasmanian alpine macrofungi is broadly similar to that recorded in the northern hemisphere, although with some notable absences. Species of *Cystoderma*, *Entoloma*, *Omphalina* and *Laccaria* are common in montane areas in the northern hemisphere (Cripps 2002, Horak 1993, Watling 1987). Although two taxa of *Entoloma* were found from Mt Wellington and the Central Plateau, this is relatively low species richness when considering the 22 *Entoloma* species recorded from the Swiss Alpine National Park (Horak 1993). Taxa commonly reported from northern hemisphere alpine areas which have not been recorded from the Tasmanian alpine zone are members of the Bolbitiaceae, Cortinariaceae and Russulales, (Ammirati & Laursen 1982,

Bendiksen *et al.* 1993, Borgen 1998, Fenner & Landa 1993, Lamoure 1987, Watling 1987), which are often associated with alpine *Salix* (Moser 1982, Senn-Irlet 1993).

The taxa recorded in this study demonstrate for the first time that macrofungi do occur in alpine Tasmania. Although the frequency and intensity of surveys in this study were limited, there were notable absences of numerous species common in nearby forests. Alpine specific surveys of greater frequency, intensity and geographic area are needed to increase the limited understanding of macrofungi in this climatic zone. The species recorded provide a basis for further surveys. It is to be hoped that future taxonomic revisions will include material collected from alpine sites, such as from the present study. Such revisions may identify further specific alpine macrofungi.

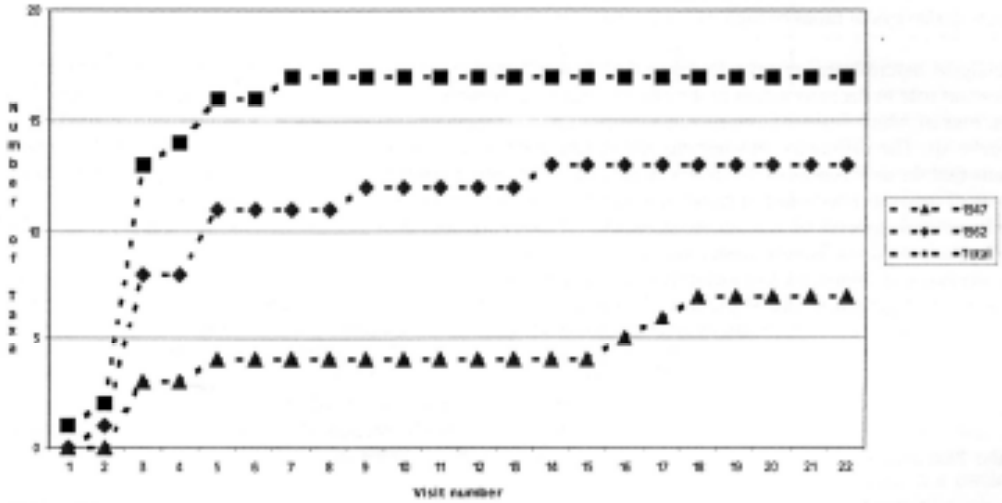


Figure 4. Species accumulation curve for repeated visits to Mt Wellington permanent sites. Burnt in 1947, burnt in 1962, total taxa observed from the alpine area of Mt Wellington.

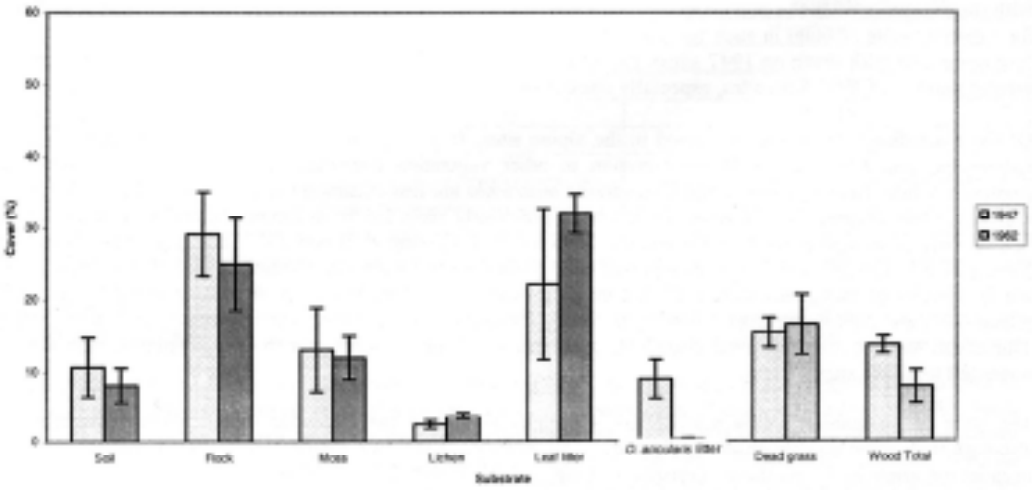


Figure 5. Comparison of substrate cover between 1947 and 1962 age class sites (averaged for each site using mid-point value for Braun-Blanquet cover classes, with standard error bars).

Acknowledgements
We thank Marco Duretto and Teresa Lebel (Royal Botanic Gardens Melbourne) and Sara Maroske for helpful comments.

References

Ammirati, J.F. & Laursen, G.A. (1982). Cortinarii in Alaskan arctic tundra *in* G.A. Laursen & J.F. Ammirati (eds), *Arctic and Alpine Mycology* **1,** 282–315.

Antibus, R.K., Croxdale, J.G., Miller, O.K. & Linkins, A.E. (1981). Ectomycorrhizal fungi of *Salix rotundifloria* III. Resynthesized mycorrhizal complexes and their surface phosphatase activities. *Canadian Journal of Botany* **59,** 2458–2465.

Bendiksen, E., Brandrud, T.E., Bendiksen, K. & Lindstrom, H. (1993). A study of the *Cortinarius helobius*-complex, with special emphasis on arctic-alpine material *in* O. Petrini & G.A. Laursen (eds), *Arctic and Alpine Mycology 3. Bibliotheca Mycologica* **150,** 3–15.

Borgen, T. (1998). *Cortinarius* subgenus *Telamonia* in Greenland *in* V.A. Mukhin & H. Knudsen (eds) *Arctic and Alpine Mycology* **5,** 26–37.

Bridle, K.L., Kirkpatrick, J.B., Cullen, P. & Shepherd, R.R. (2001). Recovery in Alpine Heath and Grassland Following Burning and Grazing, Eastern Central Plateau, Tasmania, Australia. *Arctic, Antarctic, and Alpine Research* **33,** 348–356.

Brundrett, M. (1999). Mycorrhizas of Australian Plants. http://www.ffp.csiro.au/research/mycorrhiza/ozplants.html [accessed June 2003].

Cripps, C.L. (2002). Alpine macrofungi of North America (Rocky Mountains), *in International Mycological Congress (IMC7),* Oslo, Norway. http://plantsciences.montana.edu/alpinemushrooms/imc7.htm [accessed Nov. 2002].

Fenner, R. & Landa, J. (1993). Some species of Cortinariaceae and Russulaceae in the alpine belt of the Belaer Tatras—I, *in* O. Petrini & G.A. Laursen (eds), *Arctic and Alpine Mycology 3. Bibliotheca Mycologica* **150,** 33–37.

Hobbie, E.A., Weber, N.S. & Trappe, J.M. (2001) Mycorrhizal vs saprophytic status of fungi: the isotopic evidence. *New Phytologist* **150,** 601–610.

Horak, E. (1982). Agaricales in Antarctica and subantarctica: distribution ecology and taxonomy, *in* G.A. Laursen & J.F. Ammirati (eds), *Arctic and Alpine Mycology* **1,** 82–117.

Horak, E. (1993). *Entoloma* in the alpine zone of the Alps: 1 Revision of the taxa described by J. Favre (1955). 2 New records from the Swiss National Park and other locations in the Alps *in* O. Petrini & G.A. Laursen (eds), *Arctic and Alpine Mycology 3. Bibliotheca Mycologica* **150,** 63–91.

Kirkpatrick, J.B. (1982). Phytogeographical analysis of Tasmanian alpine floras. *Journal of Biogeography* **9,** 255-271.

Kirkpatrick, J.B. (1983). Treeless plant communities of the Tasmanian High Country. *Proceedings of the Ecological Society of Australia* **12,** 61–77.

Kirkpatrick, J.B. (1997). *Alpine Tasmania: an Illustrated Guide to the Flora and Vegetation.* Oxford University Press, Australia.

Kirkpatrick, J.B. & Brown, M.J. (1984). A numerical analysis of Tasmanian higher plant endemism. *Botanical Journal of the Linnean Society* **88,** 165–183.

Kirkpatrick, J.B., Bridle, K.L. & Wild, A.S. (2002). Succession after fire in alpine vegetation on Mount Wellington. *Australian Journal of Botany* **50,** 145–154.

Kirkpatrick, J.B & Dickinson, K.J.M. (1984). The impact of fire on Tasmanian alpine vegetation and soils. *Australian Journal of Botany* **32,** 613–629.

Lamoure, D. (1987). Agaricales de la zone alpine, genus *Cortinarius* Fr., subgenus *Telamonia* (Fr.) Loud, part III *in* G.A. Laursen, J.F. Ammirati & S.A. Redhead (eds), *Arctic and Alpine Mycology* **2,** 255–271.

Laursen, G.A. (1982). Preface *in* G.A. Laursen & J.F. Ammirati (eds), *Arctic and Alpine Mycology* **1,** v–vi.

Laursen, G.A., Treu, R., Seppelt, R.D. & Stephenson, S.L. (1997). Mycorrhizal assessment of vascular plants from subantarctic Macquarie Island. *Arctic, Antarctic, and Alpine Research* **29,** 483–491.

May, T.W. (1997). Laccaria, *in* C.A. Grgurinovic, *Larger Fungi of South Australia.* The Botanic Gardens and State Herbarium and The Flora and Fauna of South Australia Handbook Committee, Adelaide.

May, T.W., Milne, J., Wood, A.E., Shingles, S., Jones, R.H. & Neish, P. (2003). *Interactive Catalogue of Australian Fungi. Version 2.0.* Australian Biological Resources Study, Canberra / Royal Botanic Gardens Melbourne. <http://www.rbg.vic.gov.au/fungi/cat/> [accessed Dec. 2002].

Moser, M. (1982). Mycoflora of the transitional zone from subalpine forests to alpine tundra *in* G.A. Laursen, J.F. Ammirati & S.A. Redhead (eds), *Arctic and Alpine Mycology* **1,** 371–389.

Ratkowsky, D.A. & Gates, G.M. (2002). A preliminary census of the macrofungi of Mount Wellington, Tasmania—the Agaricales. *Papers and Proceedings of the Royal Society of Tasmania* **136,** 89–100.

Senn-Irlet, B. (1993). The mycoflora of Alpine mire communities rich in *Salix in* O. Petrini & G.A. Laursen (eds), *Arctic and Alpine Mycology 3. Bibliotheca Mycologica* **150,** 235–249.

Trappe, J.M. (1962). Fungus associates of ectotrophic mycorrhizae. *Botanical Review* **28,** 538–606.

Warcup, J.H. (1990). The mycorrhizal associations of Australian Inuleae (Asteraceae), *Muelleria* **7,** 179–187.

Watling, R. (1987). Larger arctic-alpine fungi in Scotland, *in* G.A. Laursen, J.F. Ammirati & S.A. Redhead (eds), *Arctic and Alpine Mycology* **2,** 17–45.

Wood, A.E. (2001). Studies in the genus *Galerina* (Agaricales) in Australia. *Australian Systematic Botany* **14,** 615–676.

Young, A.M. (2000). Additions to the Hygrophoraceae (Fungi, Agaricales) of south-eastern Australia. *Muelleria* **13,** 3–36.

Young, A.M. & Wood, A.E. (1997). Studies on the Hygrophoraceae (Fungi, Homobasidiomycetes, Agaricales) of Australia. *Australian Systematic Botany,* **10,** 911–1030.

This article has been removed for copyright or proprietary reasons.

McMullan-Fisher, S. J. M., May, T. W., Keane, P. J., 2002. The macrofungal community and fire in a Mountain Ash forest in southern Australia, Fungal diversity, 10, 57-76